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CUSHMAN FOUNDATION
FOR
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Contents

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Editor
Hans E. Thalmann

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84. ARENACEOUS FORAMINIFERA FROM THE OLIGO-MIOCENE OF TRINIDAD

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Habana, Cuba[1]

The investigation of diagnostic arenaceous foraminifera from the Tertiary of Trinidad (Bronnimann, 1951) is continued in the present paper with the description of arenaceous species and genera from the Nariva formation (Oligocene), Karamat formation (Oligo-Miocene), and Cruse formation (Miocene) of Central and South Trinidad. Not much attention has been paid in the past to morphology and space-time distribution of these arenaceous foraminifera which apparently are of limited biostratigraphic significance compared with the pelagic species on which the biostratigraphic zones of Trinidad are established. On the other hand the arenaceous foraminifera are important markers of biofacies and of bathymetric environment and as such deserve a more detailed taxonomic study. *Gravellina* and *Alveovalvulinella* are diagnostic for the biofacies of the non-calcareous clays of the Nariva formation, *Jarvisella* for that of the Karamat formation, and *Recurvoides* is mainly found in the rich arenaceous faunas of the Cruse formation. Reference is also made to the internal structure of *Liebusella* Cushman 1933 and *Cubanina* Palmer 1936; the latter is considered to represent a synonym of *Liebusella* Cushman.

The author is indebted to the Management of Trinidad Leaseholds Ltd. for use of the facilities of the Geological Laboratory at Pointe-a-Pierre, Trinidad, B.W.I.; to H. G. Kugler, Trinidad, and H. E. Thalmann, Stanford, California, for reading the manuscript and for many valuable suggestions; to Ruth Todd, U. S. Geological Survey, Washington, D. C., for comparison of certain Trinidad species with types in the Cushman Collection; to A. R. Loeblich, U. S. National Museum, for specimens of *"Haplophragmoides" glomeratum* (Brady); to P. J. Bermudez, Caracas, for material from Atlantis Station 3474; to C. D. Ovey, British Museum, for topotypes of *Recurvoides contortus* Earland; to D. J. Smith, Gulf Refining Co., Harvey, Louisiana, for specimens of *Recurvoides gillieparkeri* Smith; to H. Höglund, Lysekil, for recent *Recurvoides* material from the Koster Channel, Skagerak; and to the late J. A. Cushman for a specimen of *Liebusella soldanii* (Jones and Parker) from Atlantis Station 1573.

Holotypes and figured specimens are deposited in the Cushman Collection of the U. S. National Museum in Washington, D. C. The original samples, collected mainly by K. Rohr and G. E. Higgins, geologists of Trinidad Leaseholds, remain in the collections of Trinidad Leaseholds Ltd., at Pointe-a-Pierre, Trinidad, B.W.I.

1 Now with Gulf Oil Corporation.

Family VALVULINIDAE

Genus **Gravellina** Bronnimann, n. gen.

Test trochoid spiral, composed of 4-6 whorls, elongate, cone-like, pointed at initial end, greatest diameter at last whorl, rounded in transverse section. Spiral throughout quadriserial. Chambers inflated, interior not subdivided. Sutures well defined. Aperture a rounded opening at the base of the last chamber, apparently without tooth or toothlike growth. Walls thin, not alveolar, finely arenaceous. Surface smoothly finished.

Genotype.—Gravellina narivaensis Bronnimann n. sp. Nariva formation, Oligocene, Trinidad, B.W.I.

Remarks.—Gravellina is a new monotypic valvulinid genus characterised by a throughout quadriserial arrangement of the chambers. It is perhaps related to *Makarskiana* van Soest 1942, described from the Eocene of Dalmatia (Van Soest, 1942, p. 27, pl. 1, figs. 22-25), generotype *M. trochoidea* van Soest. *Makarskiana* is 4 to 5 chambered in early and 3 to 4 chambered in late whorls and possesses an aperture with a short rounded tooth. The figures of *M. trochoidea* are not very clear, and therefore are not of much use for the interpretation of the generic definition. *Gravellina* occurs often abundantly and associated with *Alveovalvulinella pozonensis* (Cushman and Renz) in the non-calcareous clays of the ?Lower to Upper Oligocene Nariva formation of South Trinidad.

The new genus is named for the late D. W. Gravell in recognition of his valuable contributions to the knowledge of orbitoidal foraminifera of the Caribbean region.

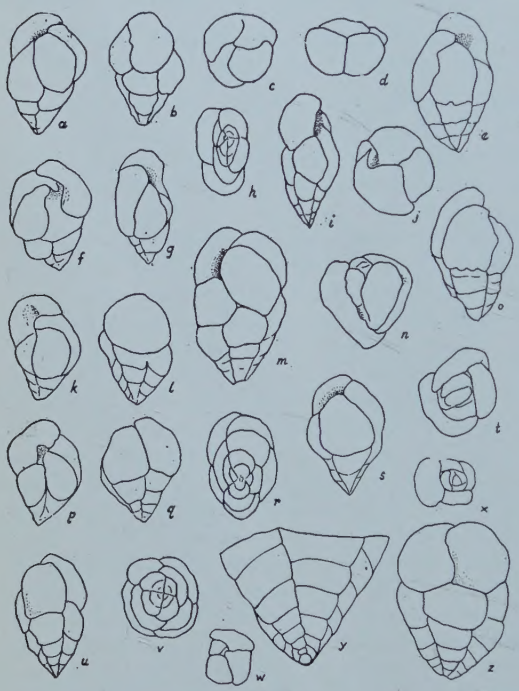
Gravellina narivaensis Bronnimann, n. sp.

Plate 15, figure 9. Textfigure 1

Well preserved specimens are elongate, rounded in cross section, cone-like, with a pointed initial end. The greatest diameter is at the apertural end. The inflated and undivided chambers increase gradually in size and are arranged quadriserially throughout the 4 to 6 whorls. The sutures, especially the longitudinal ones, are distinct excepting at the initial portion. The aperture is a rounded opening at the base of the end chamber; no tooth or toothlike growth appears to be present. The walls are finely arenaceous, non-calcareous, not alveolar, and the surface is smoothly finished. The tests are as a rule laterally or axially compressed. Laterally compressed specimens are predominant. The species is easily recognizable on account of the 2 converging lines of longitudinal sutures on both sides of

the compressed test. Normal and compressed specimens are illustrated in textfigure 1. The pointed initial end is mostly damaged, and where preserved, appears to be quadriserial (textfigure 1, y). The length of laterally compressed individuals ranges from 0.57 mm to 0.9 mm.

The species is named after the Nariva area, South Trinidad.



TEXTFIGURE 1

Holotype.—Gravellina narivaensis n. sp. Plate 15, Figure 9, 110×. K.R. 23724; T.L.L. Cat. No. 165072. Nariva formation, Oligocene, Trinidad, B.W.I. Length of test 0.63 mm., maximum diameter (final whorl) 0.48 mm.

Occurrence.—G. narivaensis occurs often abundantly in the non-calcareous clays of the Oligocene Nariva formation, associated with *Alveovalvulinella pozonensis* (Cushman and Renz), *Haplophragmoides narivaensis* n. sp., *Cyclammina cancellata* Brady and others.

Genus **Jarvisella Bronnimann**, n. gen.

Test a trochoid spiral like *Alveovalvulina* with more than 3 chambers in the initial whorl and with 3 large chambers in the adult. Chambers increase rapidly in size and the adult whorl represents the larger portion of the test. Chambers of later whorls with 2-3 shallow basal pockets produced by inward folding of walls. Interior without alveoles or radiating partitions, not labyrinthic. Walls finely arenaceous, thin. Surface smoothly finished. Exterior irregular due to the undulating surface of the lower chamber walls. Aperture arcuate, with distinct neck, situated in umbilical depression at the base of the apertural face of the end chamber.

Genotype.—Jarvisella karamatensis Bronnimann n. sp. Karamat formation, Oligo-Miocene, Trinidad, B.W.I.

Remarks.—The arrangement of the chambers, and also the general appearance of the test resembles closely *Alveovalvulina* Bronnimann (1951, p. 100, textfigs. 5-8, pl. 11, fig. 5), from which it differs by the absence of the peripheral alveoles and by the presence of the basal pockets and folds. The available material is not sufficiently well preserved for a detailed investigation of the early stages. Axial thin sections however (textfigure 3d) indicate that the early stage has more than 3 chambers in a whorl. With the exception of the basal folds the chambers of *Jarvisella* are not reinforced by interior structures and the upper portions of the thin chamber walls are therefore often compressed or crushed. *Jarvisella* is monotypic and occurs only in the non-calcareous clays of the Oligo-Miocene Karamat formation of South Trinidad.

The genus is named after P. W. Jarvis who in cooperation with J. A. Cushman started modern micropaleontologic work in Trinidad.

Jarvisella karamatensis Bronnimann, n. sp.

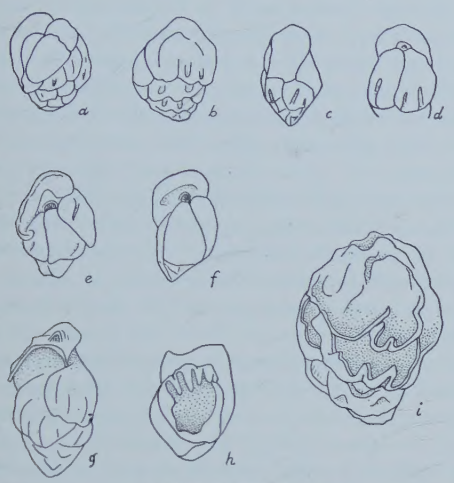
Plate 15, figure 7. Textfigures 2, 3

The 3 chambered last whorl represents the larger portion of the trochoid test. The chambers increase rapidly in size. The initial portion is rather pointed. The sutures are well defined in the adult, but indistinct in the early stages. The number of chambers in the whorls of the initial portion is therefore difficult to determine. The aperture is arcuate, with distinct neck and situated in the umbilical depression at the base of the apertural face of the end chamber. The chambers show 2 to 4 oblong basal depressions produced by the inward folding of the chamber walls (textfigure 2). These basal depressions create a characteristic undulated or ragged exterior which renders this species easily distinguishable from morphologically related forms. The apertural sides of the chambers, on the other hand, are not folded and they are not reinforced by folds, often compressed or crushed. The thin walls are very finely arenaceous, non-calcareous. The surface is smoothly finished. Deformed specimens are the rule,

EXPLANATION OF TEXTFIGURE 1

Textfigure 1. *Gravellina narivaensis* Bronnimann, n. sp. Nariva formation, Oligocene, South Trinidad, B.W.I.
a-x, z — Same specimen, K.R. 23724; T.L.L. Cat. No. 165072. All × 80.
y — K.R. 11979; T.L.L. Cat. No. 6152. × 35.

and occasionally it is difficult to separate them from badly preserved specimens of *Alveovalvulina suteri* Bronnimann which in the general features of the test comes closely to *J. karamatensis*.



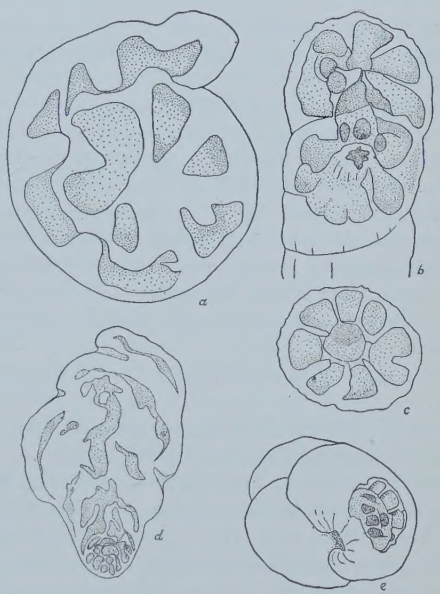
TEXTFIGURE 2

Broken up chambers (textfigure 2, g, h, i) exhibit the basal pockets produced by the inward folding of the lower chamber walls. The number of basal folds varies with the size of the chambers and appears to be 3 to 4 in the chambers of the final whorl. The pockets open widely into the chamber lumina which are only slightly restricted in the lower part. In cross section the basal pockets could be mistaken for alveoles as described in *Alveovalvulina suteri,* but no morphologic relationship seems to exist between the completely closed alveoles of *Alveovalvulina* and these structures. This type of internal subdivision is not labyrinthic.

The axial section of the initial portion (textfigure 3d) shows that the number of chambers in the early whorls must be greater than 3 and that basal folds probably do not yet occur at this stage. Adult chambers are much compressed toward the aperture. The interior of chambers and pockets is coated with a thin brown ?chitinous film. The length of tests varies from 0.325 to 0.65 mm., the maximum width from 0.225 to 0.48 mm. Sectioned specimen (textfigure 3d): Length 0.8 mm. Maximum width 0.51 mm. Diameter of initial chamber ±20μ. Thickness of outer wall in early stage ±10μ, in end chamber 30-50μ. Chamber lumina are compressed to 30-50μ.

The species is named after the Karamat area, South Trinidad.

Holotype.—Jarvisella karamatensis n. sp. Plate 15,



TEXTFIGURE 3

EXPLANATION OF TEXTFIGURES 2 & 3

Textfigure 2. *Jarvisella karamatensis* Bronnimann, n. sp. Karamat formation, Oligo-Miocene, South Trinidad, B.W.I.

a-d — Same specimen, T.L.L. Cat. Nos. 55504/506. a-c: × 80. d: × 94.
e, h — Hg. 3891; T.L.L. Cat. No. 97964. × 35.
f — Hg. 2183; T.L.L. Cat. No. 89082. × 35.
g — W.J. 304; T.L.L. Cat. No. 961. × 35.
i — Hg. 3889; T.L.L. Cat. No. 97962. × 35.

Textfigure 3.

a — *Haplophragmoides narivaensis* Bronnimann, n. sp. Nariva formation, Oligocene, South Trinidad. K.R. 23785; T.L.L. Cat. No. 165500. Appr. × 175. Oblique equatorial section.

b, c — *Liebusella* sp. aff. *L. alavensis* (Palmer). Stations Br. 532-537; T.L.L. Cat. Nos. 132287-292. South Coast of Trinidad. × 10.

b — Specimen opened obliquely to axis showing uniserial arrangement of chambers and subdivision into chamberlets.

c — End chamber of same specimen with radial partitions. Chamberlets connected with central cavity by rounded pores.

d — *Jarvisella karamatensis* Bronnimann, n. sp. Karamat formation, Oligo-Miocene, South Trinidad, B.W.I. Hg. 7353; T.L.L. Cat. No. 173043. Appr. × 40. Axial section showing the multiserial early stage and the compressed late chambers.

e — *Alveovalvulinella pozonensis* (Cushman and Renz), Nariva formation, Oligocene, South Trinidad. K.R. 23619; T.L.L. Cat. No. 163955. × 38. Apertural view of biserial stage. End chamber broken up exhibiting alveolar system.

Figure 7. 110×. Lz. 3786; T.L.L. Cat. No. 45075, Grand Lagon area, South Trinidad, B.W.I. Karamat formation, Oligo-Miocene. Length of test 0.63 mm., maximum width 0.48 mm. (laterally compressed specimen). Deposited in Cushman Collection, U. S. National Museum, Washington, D.C., U.S.A.

Occurrence.—Jarvisella karamatensis occurs commonly in the non-calcareous clays of the Oligo-Miocene Karamat formation (*Globorotalia fohsi* Zone and *Globorotalia mayeri* Zone). It is associated with *Valvulina flexilis* Cushman and Renz, *Eggerella karamatensis* n. sp., *Haplophragmoides narivaensis* n. sp. and other less common arenaceous species.

Genus **Alveovalvulinella Bronnimann**, n. gen.

Test elongate, rounded in transverse section, rapidly tapering at base. Early stage a trochoid spiral with more than 3 chambers in a whorl, then reducing to 3 chambers, then to 2 and finally to one. Uniserial portion of well developed adults consists of about 3 to 4 chambers. Interior of chambers of later whorls peripherally subdivided into small alveoles arranged normal to the outer walls. Walls arenaceous, occasionally translucent showing the interior alveolar structure. Surface smooth to fairly coarse. Sutures distinct in the uniserial but hardly discernible in the early portion. Aperture rounded, terminal, sunken, without lip or neck.

Genotype.—Liebusella pozonensis Cushman and Renz 1941.

Remarks.—Alveovalvulinella pozonensis was described by Cushman and Renz (1941, p. 9, pl. 2, figs. 1a, 1b, 2) from the Upper Oligocene to Middle Miocene, Agua Salada formation (zones 1-3), Eastern Falcon, Venezuela, as *Liebusella pozonensis*. The morphology of *Liebusella soldanii* (Jones and Parker) 1860, the genotype of *Liebusella* Cushman 1933, however differs considerably from that of *L. pozonensis* which must be attributed to a new monotypic valvulinid genus with interior peripheral alveoles and uniserial adult. The interior of the chambers of the uniserial portion of *L. soldanii* and of the variety *intermedia* (Vanden Broeck) is characterized by rather thick partitions converging from the periphery, thus producing radially arranged chamberlets which open into the central apertural cavities by rounded to oblong pores. The height of the chamberlets is identical with the height of the chambers, i. e. each chamber is developing one layer of chamberlets only. The straight radiating partitions — also called pillars — between the chamberlets connect roof and floor of each chamber. The original chamber lumina are therefore reduced by the development of secondary radial chamberlets and in the adult, the chamber is represented by the apertural cavity only. The chambers of the early stage of the test do not seem to be subdivided into chamberlets. This interesting arrangement is well exposed by the broken up specimen of *L. soldanii*, from off Key West, Florida, 78 fathoms, figured by Cushman (1937, pl. 20, fig. 5) and by recent specimens of *L. soldanii* and of *L. soldanii* var. *intermedia* from Atlantis Station No. 3474, Lat. 23° 18′ N, Long. 80° 46′ W, off Province Oriente, Cuba, 490 fathoms (textfigures 6, 8, 9) which were kindly donated by P. J. Bermudez, Caracas. The axial section of a recent specimen of *L. soldanii*, figured by Brady (1884, pl. 32, fig. 17) as *Haplostiche soldanii*, clearly shows the thick arenaceous walls, the low chambers and the straight and rather thick partitions of the chamberlets. *L. goësi* Höglund 1947, reported from the Gullmar Fjord and the Skagerak, shows a similar radial subdivision of the uniserial chambers (Höglund, 1947, pl. 14, fig. 8) and was termed "sublabyrinthic" by Höglund (p. 197). The aperture, in general, is placed in crater like depressions. The type of aperture is extremely variable.

In order to demonstrate the internal structure of *L. soldanii* and its variety *intermedia* the calcareous walls of recent specimens from Atlantis Station 3474 were etched in steps with HCl. The sections obtained after each application of HCl were drawn with an Abbé Mirror and compiled in textfigures 5, 6, 8, 9. *L. soldanii* (textfigure 8) is figured first from the outside showing the stout test and the rather indistinct sutures (a). In the following 4 steps (b-e) the radial chamberlets appear and the rounded openings into the central apertural cavities. Then the radial chamberlets of the 4 uniserial chambers and part of the chambers of the preceding stages are opened (f-i). It is of interest to note that the 2 radiating chamberlets of the end chamber are leading to a single opening in the apertural cavity, i. e. the partition does not reach the centre and the chamberlets are not completely separated. The 3 final stages (k-m) expose the initial portion, the apertural cavities and the passages between chamberlets and cavities (black spots). The end chamber of *L. soldanii* (textfigure 6) possesses a rather indistinct and irregularly shaped terminal aperture (a), which opens into the central apertural cavity (b). The following sections expose the apertural cavity and the radiating chamberlets (c) and the connections between chamberlets and cavity (d, e). The internal structure of *L. soldanii* var. *intermedia* is shown in textfigure 9. The variety is more slender and has more definite sutures than the parent species. The sections (a-g) reveal complete agreement in the internal structure with *L. soldanii*.

Vanden Broeck (1876, p. 76) described the internal structure of *Liebusella soldanii* var. *intermedia* v.d.B. from Barbados as follows: ". . . . chacune des loges se trouve elle-même subdivisée en un certain nombre de compartiments au moyen de cloisons secondaires, dressées perpendiculairement sur le plancher des loges. C'est alors le type composé dans lequel l'ouverture devient dendritique ou multiple." This description, illustrated by excellent sections (pl. 2, figs. 3, 4, and 6) is confirmed by the present investigation. The term

"labyrinthic," however, has not been used by vanden Broeck.

The chambers of the initial portion of *L. soldanii,* as far as it could be ascertained by the acid treatment (textfigure 5e) appear to be in a linear arrangement. The position of the apertures however suggest that the true arrangement is multiserial. The interior of *Liebusella* therefore, *is not labyrinthic,* although the impression of a labyrinthic arrangement could be created by tangential sections parallel or oblique to the axis of the test. The present author does not agree with Palmer (1938, p. 284) who described the recent *L. soldanii* as being a form with "labyrinthic" chambers whereby "labyrinthic" is defined as follows (p. 288) " . . . in the longitudinal section of *Liebusella* it is clear that there are separated tiers of partitions which are not aligned and which are separated by irregular horizontal partitions parallel to the floors and ceilings of the chambers." The specimens described and figured in this paper (textfigures 5, 6, 8, 9), the broken specimen of Cushman and the axial section of Brady, however, do not show such an irregular structure, and also Palmer's axial section of a fossil specimen of *L. soldanii* from the Upper Oligocene Cojimar formation of Cuba (1938, pl. 22, fig. 21) exhibits a fairly regular arrangement of cavities in horizontal layers which correspond to the chamberlets of a chamber. No indication of a labyrinthic interior is to be seen.

Palmer (1938, p. 284) assigned specimens with "labyrinthic" chambers exemplified by recent specimens of *L. soldanii* to *Liebusella* Cushman, 1933, sensu stricto. On the other hand specimens with non-labyrinthic, but partitioned chambers were referred to the genus *Cubanina* Palmer 1936, typified by *C. alavensis* Palmer. As the chambers of recent specimens of *L. soldanii* are subdivided by radiating partitions into chamberlets, *Liebusella* and *Cubanina* cannot be distinguished and the latter becomes a synonym of *Liebusella.* According to Palmer's figures on pl. 22, the only remaining difference between *C. alavensis* and *L. soldanii* is the greater height of the chambers and the larger chamberlets in *C. alavensis* when compared with *L. soldanii.* Should these features be constant, the two forms are very probably only different species. The number of chamberlets appears to be of the same order (about 10) in *C. alavensis* (Palmer, 1938, pl. 22, fig. 9) and in *L. soldanii* (see textfigure 6).

A recent specimen from the South Coast of Trinidad (textfigure 3b, c) (Br. 532-537; T.L.L. Cat. Nos. 132287-292) which from the exterior closely resembles *L. soldanii* was also opened with acid and revealed the same internal structure as typical representatives of *Liebusella,* with the exception of the much greater height and width of the chambers and the greater dimensions of the openings between chamberlets and central apertural cavity. In addition the number of radiating chamberlets is only 8 against 10 of the examined specimens of *Liebusella.* It is possible that specimens of this type were assigned by Palmer to *Cubanina.*

Thus *Liebusella Cushman* 1933, sensu stricto, as defined by Palmer 1938, differs considerably from *Alveovalvulinella,* which is characterized by numerous small alveoles covering the interior of the chambers. The chamber lumina are only slightly reduced by the development of alveoles which open widely into the chambers. *Alveovalvulinella,* on the other hand, is closely related to the adult triserial *Alveovalvulina* Bronnimann 1951, from which it is distinguished by the uniserial adult test and the rounded terminal aperture. Early stages of *Alveovalvulina* and of *Alveovalvulinella* are very similar, perhaps identical (Bronnimann 1951, textfigure 7a-7d, 8).

Alveovalvulinella is monotypic and occurs in the Oligocene of Trinidad, Venezuela, and Costa Rica.

Alveovalvulinella pozonensis
(Cushman and Renz), 1941
Plate 15, figure 3. Textfigures 3-7

Liebusella pozonensis Cushman and Renz, 1941, Cushman Lab. Foram. Research, Contr., Vol. 17, p. 9.—Renz, H. H., Proc. 8th Am. Sci. Congress, 1942, p. 546 (list).—Cushman, J. A., 1947, Cushman Lab. Foram. Research, Spec. Pub. No. 8A, p. 58, pl. 8, figs. 26, 27.—Renz, H. H., Geol. Soc. America, Memoir 32, 1948, p. 144, pl. 2, figs. 19a, b, 20.

Liebusella pozonensis Cushman and Renz var. *crassa* Cushman and Renz, 1941, Ibid., p. 10.—Cushman, J. A., 1947, Cushman Lab. Foram. Research, Spec. Pub. No. 8A, p. 58, pl. 8, figs. 26, 27.—Renz, H. H., 1948, Geol. Soc. America, Memoir 32, p. 144, pl. 2, figs. 21, 22.

Cushman and Renz's original description of the parent species is as follows:

"test of medium size, subcylindrical, rapidly tapering at the base, the adult with the sides nearly parallel, somewhat lobulate; chambers of the early portion indistinct, the triserial portion usually followed directly by the uniserial stage which consists of 3-4 chambers, interior labyrinthic; sutures of the earlier portion indistinct, in the uniserial portion distinct and depressed; wall finely arenaceous with much cement, somewhat translucent and showing the interior structure; aperture rounded, terminal. Length 0.95-1.30 mm., diameter 0.35-0.50 mm."

The Trinidad material corresponds perfectly with that from Venezuela, represented in the collections of Trinidad Leaseholds by the original samples H.S.R. 921, T.L.L. Cat. No. 19787 and L.P. 129, T.L.L. Cat. No. 22675.

The variety *crassa* has been put in synonymy with the parent species, as the differences put forward by Cushman and Renz (1941, p. 10) appear to be due to slightly different preservation which does not warrant the establishment of a new variety. The occurrence of

A. pozonensis in H.S.R. 921 is possibly allochthonous. The sample L.P. 129 is homogeneous and contains *Orbulina suturalis* Bronnimann, *Globorotalia fohsi barisanensis* LeRoy, and *Globorotalia mayeri* Cushman and Ellisor, an association which indicates an Upper Oligocene, *Globorotalia fohsi barisanensis* age of the fauna.

TEXTFIGURE 4

The description of the exterior by Cushman and Renz does not need much amplification. It may be added that the sutures are frequently indentated indicating the basal rows of interior alveoles. Undeveloped tests, usually of the biserial stage are common. The tests are occasionally more or less compressed. The aperture is textularia-like in the early biserial stage (textfigure 4, b, c), later it becomes partly enclosed and subterminal (textfigure 4, d, f), and finally terminal (textfigure 4, g, h) in the adult stage. The number of chambers of the early whorls cannot be determined due to the obscure sutures.

The term labyrinthic has to be replaced in the original description by alveolar. The presence of alveoles is occasionally suggested by subcircular depressions on the surface which is also observed in *Alveovalvulina*. In worn specimens alveoles are often exposed. The alveoles are arranged normal to the walls and they open widely into the chamber lumina, which are not much reduced by the alveolar wall structure (textfigures 6g, h, 7). Early ontogenetic chambers apparently do not possess alveoles. The number of alveoles is increasing with the size of the chambers, and in axial sections of late ontogenetic chambers 5-9 alveoles have been counted. In well preserved specimens the inner walls of alveoles and chambers are coated with a thin, brown ?chitinous film. Axial sections of specimens from the Agua Salada formation of Venezuela (L.P. 190; T.L.L. Cat. No. 22620) exhibit the alveolar structure and uniserial adult typical for *Alveovalvulinella* (textfigure 7).

Dimensions of sectioned specimens

Specimen 1, L.P. 190, T.L.L. Cat. No. 22620. Agua Salada formation, Venezuela.
- Length of test 1.03 mm. (4 uniserial chambers)
- Maximum diameter of test 0.4 mm.
- Maximum diameter of initial chamber ±0.12 mm.
- Diameter of alveoles of end chamber ±50μ
- Thickness of walls of initial portion ±15μ
- Thickness of walls of end chamber ±25μ

Specimen 2, L.P. 190, T.L.L. Cat. No. 22620, Agua Salada formation, Venezuela.
- Length of test 1.33 mm.
- Maximum diameter of test 0.64 mm.
- Diameter of alveoles of early chambers 30-50μ
- Diameter of alveoles of late chambers 50-65μ
- Thickness of wall of end chamber ±25μ

Specimen G. 5160A, Nariva formation, Trinidad.
- Length of test 1.27 mm.
- Maximum diameter of test 0.496 mm.
- Diameter of initial chamber ±40μ
- Diameter of alveoles 30-65μ
- Thickness of walls of early chambers ±15μ
- Thickness of walls of end chamber ±30μ

Specimen K. R. 23619, T.L.L. Cat. No. 163955, Nariva formation, Trinidad. (Only fragment of initial portion).
- Diameter of initial chamber ±30μ
- Thickness of wall of early chambers ±15μ
- Diameter of alveoles 30-50μ

Holotype.—Alveovalvulinella pozonensis (Cushman and Renz), from Pozon, 17.7 km. Southeast of Pueblo Jacura, District Acosta, State Falcon, Venezuela. Deposited in Cushman Collection, U. S. National Museum, Washington, D. C., No. 35902.

Occurrence.—A. pozonensis has been recorded from the Oligo-Miocene of Venezuela (Agua Salada formation, lower zone of Carapita shale), Trinidad (Brasso formation, Nariva formation), and from the Amoura shale of Costa Rica. It is diagnostic for the non-calcareous shales of the Nariva formation of South Trinidad, where it is associated with *Gravellina narivaensis* n. sp., *Haplophragmoides narivaensis* n. sp., and others.

Genus **Eggerella Cushman,** 1933

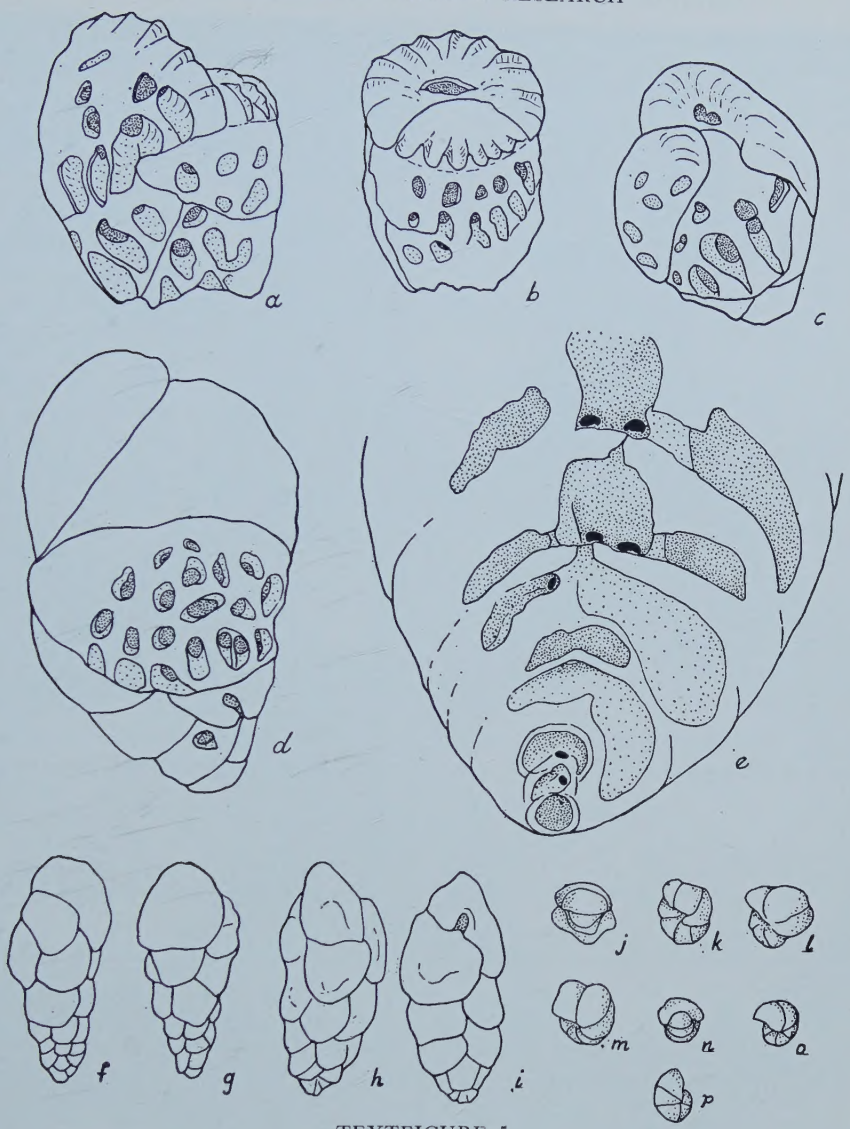
Eggerella karamatensis Bronnimann, n. sp.

Plate 15, figure 2. Textfigure 5f-i

The elongate, slightly tapering test is a trochoid

EXPLANATION OF TEXTFIGURE 4

Textfigure 4. *Alveovalvulinella pozonensis* (Cushman and Renz), Nariva formation, Oligocene, South Trinidad. K.R. 23783; T.L.L. Cat. No. 165498. × 25.
b, c — Young individuals, tri-biserial.
a, d-f — Biserial stage, aperture tends to become terminal.
g, h — Adult individuals, uniserial, terminal aperture. g with broken up end chamber, alveoles.



TEXTFIGURE 5

EXPLANATION OF TEXTFIGURE 5

Textfigure 5.

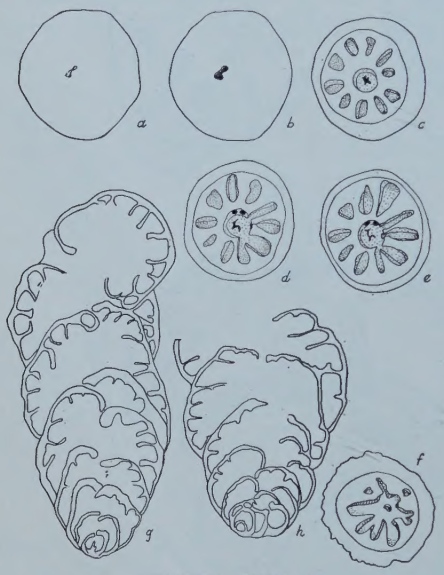
a-d — *Alveovalvulina pozonensis* (Cushman and Renz), Nariva formation, Oligocene, South Trinidad.
a-c — K.R. 23534; T.L.L. Cat. No. 164033.
d — K.R. 23619; T.L.L. Cat. No. 163955.
All × 70.
Superficially eroded specimens showing alveolar system.

e — *Liebusella soldanii* (Jones and Parker). Atlantis Station 3474, Lat. 23° 18′ N, Long. 80° 46′ W, off Oriente Province, Cuba, 490 fathoms. × 55. Same specimen as in Textfigure 8. Initial portion slightly deeper eroded than stage m of Textfigure 8, showing initial chamber.

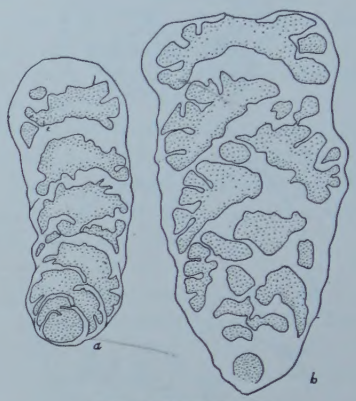
f-i — *Eggerella karamatensis* Bronnimann, n. sp. Karamat formation, Oligo-Miocene, South Trinidad, B.W.I. Hg. 7351; T.L.L. Cat. No. 173017. × 55.
f, g — Same specimen.
h, i — Same specimen.

j-p — *Haplophragmoides narivaensis* Bronnimann, n. sp. Nariva formation, Oligocene, South Trinidad. K.R. 23785; T.L.L. Cat. No. 165500. All × 40.

spiral of about 4 to 5 whorls, rounded at the initial end and broadest at the apertural end. The initial whorl is composed of more than 3 chambers, the final 3 to 4 whorls are triserial. The rather high subglobular chambers increase gradually in size. The sutures are well defined. The aperture appears to be a rounded opening at the base of the apertural face of the end chamber. The non-calcareous walls are finely to coarsely arenaceous and the surface is smoothly finished. The tests are frequently deformed.



TEXTFIGURE 6



TEXTFIGURE 7

A maximum length of 0.32 mm. to 0.67 mm. and a maximum diameter of 0.22 mm. to 0.3 mm. was measured on slightly deformed specimens.

Holotype.—Eggerella karamatensis n. sp. Plate 15,

EXPLANATION OF TEXTFIGURES 6 & 7

Texfigure 6.

a-f — *Liebusella soldanii* (Jones and Parker).

a-e — Atlantis Station 3474, Lat. 23° 18′ N, Long. 80° 46′ W, off Oriente Province, Cuba, 490 fathoms. All × 9. Same specimen, seen from the apertural side, showing successive stages obtained by application of H Cl.

f — Atlantis Station 1573, to Cape Cruz, Cuba, 305 fathoms. × 9.

g, h — *Alveovalvulinella pozonensis* (Cushman and Renz), Nariva formation, Oligocene, South Trinidad. All appr. × 40.

g — G. 5160A.

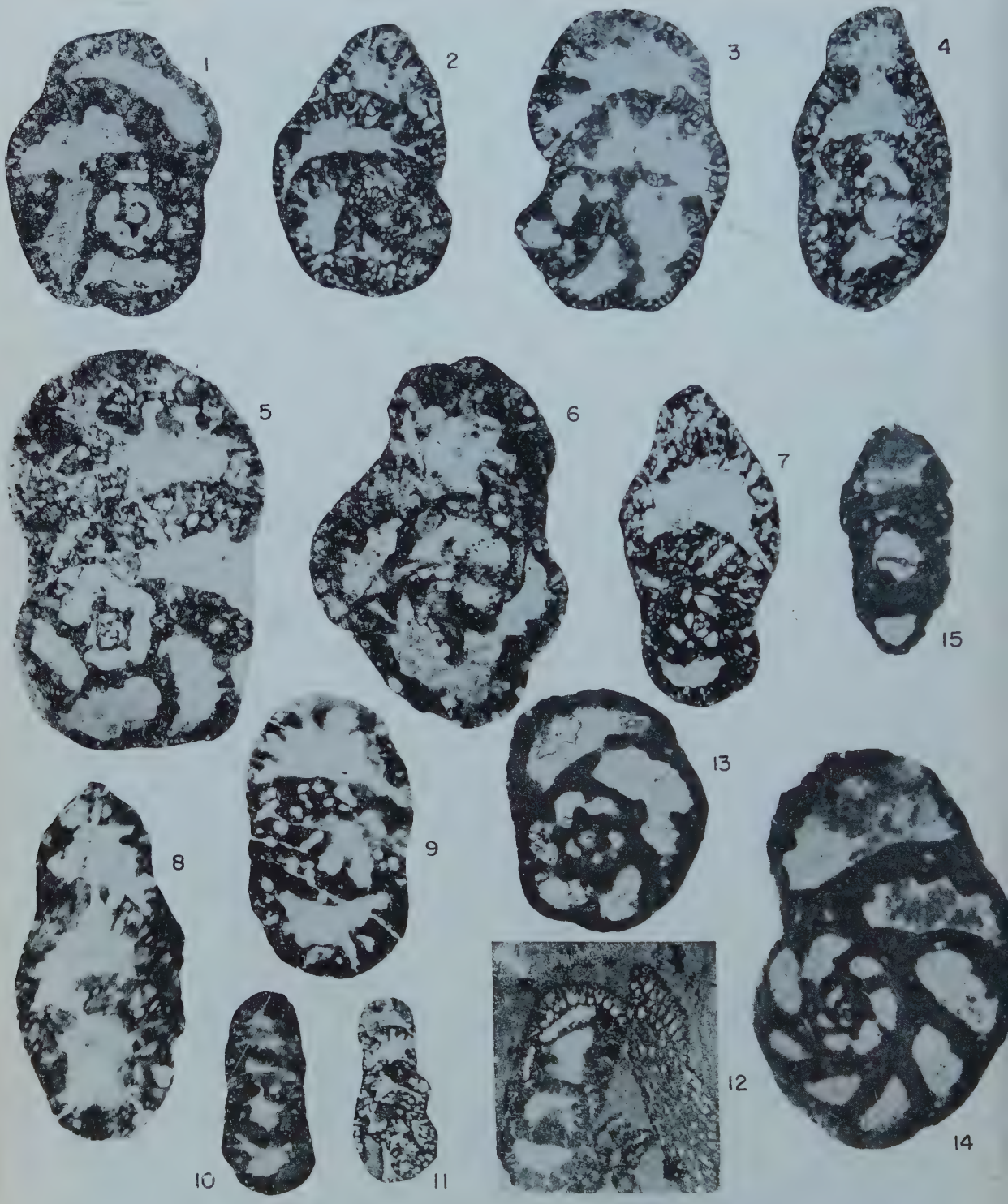
h — K.R. 23619; T.L.L. Cat. No. 163955.

Axial sections of biserial microspheric individuals showing the internal alveolar structure.

Textfigure 7. *Alveovalvulinella pozonensis* (Cushman and Renz), Agua Salada formation, Venezuela. L.P. 190; T.L.L. Cat. No. 22620, Appr. × 40. Axial sections.

EXPLANATION OF PLATE 15

Bronnimann: Arenaceous Foraminifera, Oligo-Miocene, Trinidad



Maync: Pseudocyclammina hedbergi, n. sp.

Figure 2. 110×. Hg. 7351; T.L.L. Cat. No. 173017. Karamat formation, Oligo-Miocene, South Trinidad. Length: 0.65 mm., maximum width: 0.3 mm. Deposited in Cushman Collection, U. S. National Museum, Washington, D. C.

Remarks.—*E. karamatensis* differs from *E. forestensis* n. sp. in the elongate, gradually tapering test, the smaller final whorl in relation to the size of the test, and the larger chambers. It is named after the Karamat area, South Trinidad.

Occurrence.—*E. karamatensis* is a common species of the Oligo-Miocene Karamat faunas, associated with *Jarvisella karamatensis* n. sp., *Haplophragmoides narivaensis* n. sp., and others.

Eggerella forestensis Bronnimann, n. sp.

Plate 15, figure 8. Textfigure 15a-g

The test is a small trochoid spiral of about 4 whorls, pointed at the initial end and broadest at the apertural end. The initial whorl contains 4 or more chambers, and the following whorls are throughout triserial. The chambers increase rapidly in size so that the final whorl represents about half of the test. The sutures are well marked. The aperture is an indistinct opening at the base of the apertural face of the end chamber. The walls are finely to coarsely arenaceous depending on the type of environment, and the surface is smoothly finished. The tests are laterally, occasionally axially compressed, indicating that the chambers are not subdivided and that the walls are thin.

The length of the tests is from 0.25 mm. to 0.65 mm. and the maximum width from 0.25 mm. to 0.4 mm. These dimensions refer to compressed specimens.

Holotype.—*Eggerella forestensis* n. sp. Plate 15, Figure 8. 110×. T.L.L. Cat. No. 5220. Cruse formation, Miocene, South Trinidad. Length 0.45 mm., maximum width: 0.325 mm. Deposited in Cushman Collection, U. S. National Museum, Washington, D. C.

Remarks.—Specimens of *E. forestensis* were compared by Miss R. Todd, U. S. Geological Survey, with the other species of *Eggerella* deposited in the Cushman Collection and found to be different.

The name is derived from Forest field, South Trinidad.

Occurrence.—*E. forestensis* occurs commonly in the silts and silty clays of the Miocene Cruse formation. It is a facies marker like (?)*H.* aff. *H. narivaensis* n. sp. with which it is mostly associated.

Genus **Valvulina** Orbigny, 1826

Valvulina flexilis Cushman and Renz, 1941

Plate 15, figure 1. Textfigure 15h-o

Valvulina flexilis Cushman and Renz, 1941, Cushman Lab. Foram. Research, Contr., Vol. 17, p. 7, pl. 1, figs. 16, 17.—Cushman, J. A. and Stainforth, R. M., 1945, Cushman Lab. Foram. Research, Special Pub. No. 14, p. 17, pl. 2, fig. 4.—Cushman, J. A., 1947, Cushman Lab. Foram. Research, Special Pub. No. 8A, p. 5, pl. 1, figs. 8a-c.—Cushman, J. A. and Renz, H. H., 1947, Cushman Lab. Foram. Research, Special Pub. No. 22, p. 7, pl. 1, fig. 19.—Renz, H. H., 1948, Geol. Soc. America, Memoir 32, p. 177, pl. 2, figs. 12a-c.

Specimens from the Upper Oligocene and from the Lower Miocene of Trinidad appear to be identical with those described from the Upper Oligocene to Middle

EXPLANATION OF PLATE 16

Figs. — Page

1-8. *Pseudocyclammina hedbergi* Maync, n. sp. 101

Figs. 1-5. El Cantil, Rio Punceres, State of Monagas, Venezuela. Lower Chimana formation ("El Cantil" *auct.*), Middle Albian.

Fig. 1. Holotype. Median section showing large inflated chambers. × 27. U.S.N.M. No. 64541.

Fig. 2. Shallow median section displaying thick labyrinthic septa and walls with some agglutinated quartz grains and foraminifera. × 27. U.S.N.M. No. 64542.

Fig. 3. Median section. × 27. U.S.N.M. No. 64543.

Fig. 4. Transverse section. × 27. U.S.N.M. No. 64544.

Fig. 5. Median section. × 30. U.S.N.M. No. 64545.

Figs. 6-7. Las Cinco Ceibas, Cumaná Highway, State of Sucre, Venezuela. Upper Barranquin formation (Lower Aptian).

Fig. 6. Median section. × 27. U.S.N.M. No. 64546.

Fig. 7. Axial section. × 27. U.S.N.M. No. 64547.

Fig. 8. Lower Cretaceous (Trinity), Pinellas County, Florida, Coastal Petroleum Company's deep-well No. 1, at 10,050-60′ depth. Subaxial section. × 30.

9-12. *Pseudocyclammina* sp. 102

Figs. 9-11. El Hondón Valley, Sierra de Jatibonico, Province Santa Clara, Cuba. Upper Aptian *Choffatella* limestone.

Fig. 9. × 70.

Fig. 10. × 27.

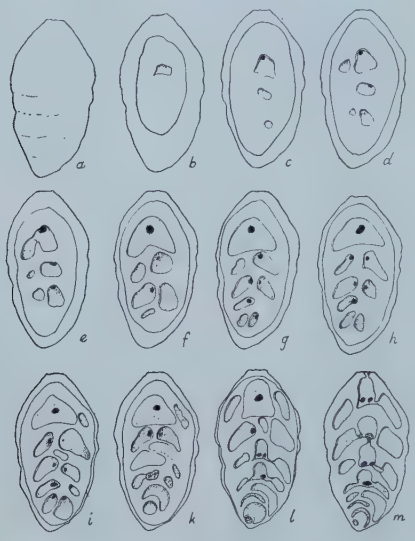
Fig. 11. × 27.

Fig. 12. El Cantil, Rio Punceres, Lower Chimana formation (*Orbitolina* limestone, "El Cantil" *auct.*). Transverse section with broadly rounded periphery. × 27.

13-15. *Pseudocyclammina virguliana* Koechlin 102

(Type figures ex Koechlin, 1942, Pl. VI, figs. 1, 2, 4). La Chaux, Bernese Jura Mountains, Switzerland. Kimmeridgian Jurassic. × 36.

Miocene clays of the Agua Salada formation of Venezuela. The specimens are as a rule much compressed or crushed. The amount of cement and the colour of the test is very variable. Sutures are occasionally less distinct than in the Venezuelan forms. The large flattened tooth referred to by Cushman was not observed.



TEXTFIGURE 8

Holotype.—Valvulina flexilis Cushman and Renz. Aguide, 3.85 km. Southeast of Pueblo Aguide, District Acosta, State Falcon, Venezuela. Deposited in Cushman Collection, U. S. National Museum, Washington, D. C., No. 35925.

Occurrence.—Valvulina flexilis has been recorded in Trinidad from the *Globorotalia fohsi* Zone and from the *Globigerina* cf. *concinna* Zone of the Cipero formation, and from the *Globigerinatella insueta* Zone of the Ste. Croix type locality. The species also occurs in the Nariva, Karamat, Lengua, and Cruse formations of Trinidad. In Venezuela it has only been reported from the Agua Salada formation.

Genus **Haplophragmoides** Cushman, 1910

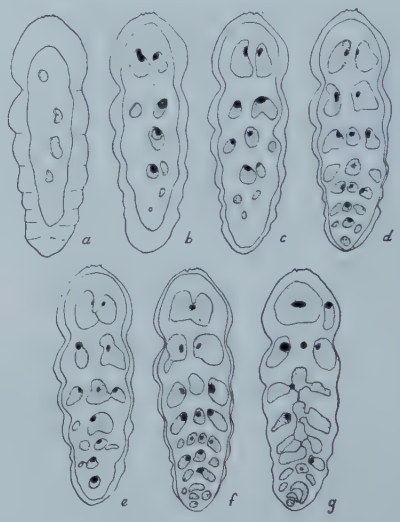
Haplophragmoides narivaensis Bronnimann, n. sp.

Plate 15, figure 4. Textfigures 3a, 5j-p

The very small planispiral and involute test is composed of about 2 volutions, the last of which is 5 to 7 chambered. The umbilici are deep and small. The chambers tend to become elongate in axial direction and they increase rapidly in size so that the end chamber is about twice the size of the first chamber of the last volutions. The sutures are indistinct thus the periphery is only weakly lobulate. The aperture is not visible. The slightly oblique equatorial section of an ironstained specimen shows that the aperture of the penultimate chamber is interiomarginal. Those of the earlier chambers are not known. The walls are finely to coarsely arenaceous. The surface is smoothly finished.

The maximum diameter ranges from 0.20 mm. to 0.27 mm., the average is about 0.25 mm. The species is named after the Nariva area, South Trinidad.

Holotype.—Haplophragmoides narivaensis n. sp. Plate 15, Figure 4. 110×. K.R. 23785; T.L.L. Cat. No. 165500. Nariva formation, Oligocene, South Trinidad. Maximum diameter 0.2 mm., axial diameter of end chamber 0.2 mm. Deposited in Cushman Collection, U. S. National Museum, Washington, D. C.



TEXTFIGURE 9

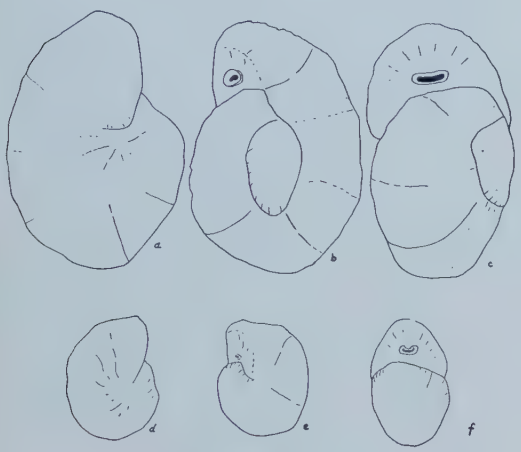
Remarks.—H. narivaensis is as a rule strongly deformed. The aperture has only been observed in an equatorial section (textfigure 3a), where it appears to be interiomarginal. The proloculum is not known. *H. narivaensis* resembles in size *H. pusillum* Höglund 1947 and *"H." glomeratum* (Brady). It is distinguished from *H. pusillum* by the deep and small umbilici and by the axial elongation of the chambers. *"H." glomeratum* with axially elongate chambers is now assigned to the genus *Adercotryma;* it is fully discussed in a recent paper by A. R. Loeblich and Helen Tappan (1953, p. 26). Representatives of this peculiar arena-

EXPLANATION OF TEXTFIGURES 8 & 9

Textfigure 8. *Liebusella soldanii* (Jones and Parker), Atlantis Station 3474, Lat. 23° 18′ N, Long. 80° 46′ W, off Oriente Province, Cuba, 490 fathoms. All × 9.
a-m — Same specimen, showing successive stages obtained by application of H Cl.

Textfigure 9. *Liebusella soldanii* (Jones and Parker) var. *intermedia* vanden Broeck. Atlantis Station 3474, Lat. 23° 18′ N, Long. 80° 46′ W, off Oriente Province, Cuba, 490 fathoms. All × 9.
a-g — Same specimen treated with H Cl.

ceous species, collected by Captain Bartlett from off Clavering Island, N. E. Greenland, 50 to 51 fathoms, were very obligingly loaned for comparison by A. R. Loeblich, U. S. National Museum, and from the Heron-Allen and Earland collection of the British Museum by C. D. Ovey.



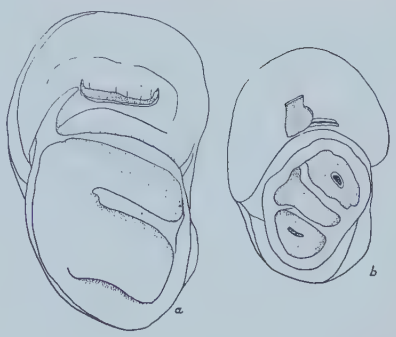
TEXTFIGURE 10

H. narivaensis is smaller and more involute than *H. canariensis* (Orbigny) and has in general a smaller number of chambers in the final whorl. The last chambers of *H. canariensis* are not elongate in axial direction (Brady, p. 310, pl. 35, figs. 1-3).

Occurrence.—*H. narivaensis* occurs commonly in the non-calcareous clays of the Oligocene Nariva formation and in the Oligo-Miocene Karamat formation of South Trinidad.

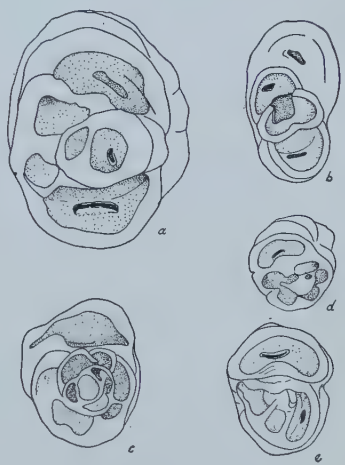
(?)**Haplophragmoides** aff. **H. narivaensis** Bronnimann
Textfigure 15

This 5 chambered planispiral species resembles *H. narivaensis*. It is invariably axially compressed. The aperture is not visible, and the generic position therefore is uncertain. The non-calcareous test is rather coarsely arenaceous, the surface is smoothly finished. The maximum diameter of the axially compressed figured specimens is from 0.38 to 0.45 mm.



TEXTFIGURE 11

Occurrence.—(?)*H.* aff. *H. narivaensis* is an important facies marker of the silts and silty clays of the Miocene Cruse formation. In general it occurs alone or associated with *Eggerella forestensis* n. sp.



TEXTFIGURE 12

Genus **Recurvoides** Earland, 1934
Recurvoides obsoletum (Goës), 1896
Plate 15, figure 6. Textfigures 10-13

Haplophragmium obsoletum Goës, 1896, The Foraminifera: Harvard Coll. Mus. Comp. Zool., Bull., Vol. 29, p. 31, pl. 3, figs. 14-16.

EXPLANATION OF TEXTFIGURES 10, 11 & 12

Textfigure 10. *Recurvoides obsoletum* (Goës). Cruse formation, Miocene, South Trinidad. Hg. 7330. T.L.L. Cat. No. 172616. All × 27.
a-c — Same specimen.
d-f — Same specimen.

Textfigure 11. *Recurvoides obsoletum* (Goës). Cruse formation, Miocene, South Trinidad. All × 27.
a — Hg. 7337; T.L.L. Cat. No. 172623. Apertural view, 2 last chambers removed.
b — Hg. 7566; T.L.L. Cat. No. 174323. Early chambers of final volution broken up showing the interior of chamber and the apertures.

Textfigure 12.
a, b — *Recurvoides obsoletum* (Goës). Cruse formation, Miocene, South Trinidad. All × 27.
a — Hg. 7270; T.L.L. Cat. No. 172795.
b — Hg. 7330; T.L.L. Cat. No. 172616.
c-e — *Recurvoides higginsi* Bronnimann, n. sp. Cruse formation, Miocene, South Trinidad. All × 27.
c — T.L.L. Cat. No. 2359.
d, e — Hg. 7260; T.L.L. Cat. No. 172785.

The chambered test is streptospiral. The outline is broad ellipsoid in umbilical and oblong in apertural view. The umbilical side is almost flat, the opposite side is slightly convex. The umbilicus is occasionally indicated by a faint depression. The earliest chambers of the streptospiral test are completely hidden and only those of the final whorl, occasionally one or two chambers of the preceding whorl are visible. The final volution is about 7 chambered. The sutures, particularly of large specimens, are almost indiscernible. The slit like aperture is interioareal, above the base of the apertural face like that of *Labrospira,* and surrounded by a distinct collar. The shape of the aperture is variable. The apertural face is arcuate and forms an angle with the surface of the final whorl. The thick walls are finely to coarsely arenaceous, depending on the type of environment, and non-calcareous. The end chamber is rather coarsely textured. The surface is smooth, but not shining. The interior of the chambers is coated with a brown ?chitinous film.

The maximum diameter across the umbilical side ranges from 0.55 mm. to 1.35 mm., the average is from 0.9 to 1.25 mm.

Holotype.—Haplophragmium obsoletum Goës. Recent. Albatross Station 2140, Lat. 17° 36′ N, Long. 76° 46′ W, 966 fathoms, Caribbean sea, about 23 miles South South East from Port Royal, Jamaica.

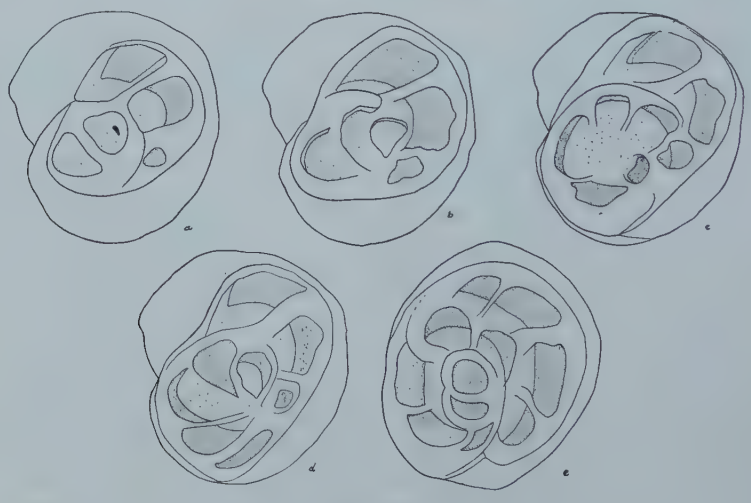
Remarks.—The Trinidad specimens agree in structure and size perfectly with recent specimens of *R. obsoletum* from Atlantis Station 3474, Lat. 23° 18′ N, Long. 80° 46′ W, off Province Oriente, Cuba, 490 fathoms, kindly donated by P. J. Bermudez, Caracas. One of the Atlantis specimens, which have rather coarsely finished calcareous tests, has been etched with diluted HCl, and the successive steps have been illustrated in textfigure 23. The Atlantis specimens measure across the umbilical side 1.05 mm. to 1.3 mm. Goës figures of *R. obsoletum* (diameter 1-2 mm.) are not very clear (1896, pl. 3, figs. 14-16) but give the general character of the test. Trinidad specimens, although the chambers are fairly thick walled, are frequently compressed or otherwise deformed. The streptospiral arrangement of the Miocene specimens is illustrated in textfigures 11 and 12a, b. From the position of the aperture it can be seen, that the axis of coiling can shift through 90°.

Occurrence.—This large and conspicuous species is commonly represented in the clays of the Miocene Cruse formation and Lengua formation, South Trinidad. It is associated with *Discamminoides tobleri,* Bronnimann, *Valvulina flexilis* Cushman and Renz, *Alveovalvulina suteri* n. sp., *Cyclammina cancellata* Brady, *Glomospira charoides* (Jones and Parker), *Glomospira gordialis* (Jones and Parker), *Guppyella miocenica* (Cushman), *Ammodiscus tenuis* Brady, (?) *Haplophragmoides* aff. *H. narivaensis* n. sp., *Recurvoides higginsi* n. sp., and others.

Recurvoides higginsi Bronnimann, n. sp.

Plate 15, figure 5. Textfigures 12, 14

The streptospiral test is relatively small, subglobular and biumbilicate. The last whorl is 6 to 7 chambered. The sutures are indistinct. The small slit like aperture is interioareal, above the base of the apertural face, like *Labrospira* and surrounded by a collar. The thick walls are finely to coarsely arenaceous. The surface is smoothly finished and shining as if polished. The interior of the chambers is coated with a thin ?chitinous film.

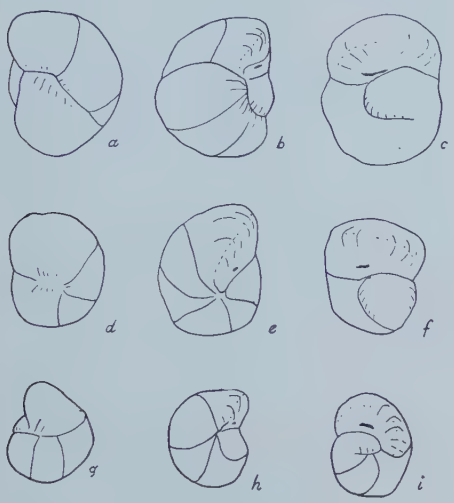


TEXTFIGURE 13

EXPLANATION OF TEXTFIGURE 13

Textfigure 13. *Recurvoides obsoletum* (Goës). Atlantis Station 3474, Lat. 23° 18′ N, Long. 80° 46′ W, off Oriente Province, Cuba, 490 fathoms. × 9. Same specimen treated with H Cl to show the streptospiral volutions.

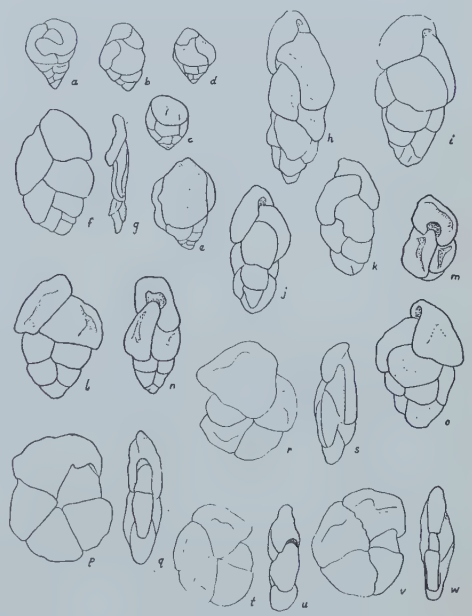
The maximum diameter ranges from 0.27 to 0.65 mm., the average is from 0.35 mm. to 0.5 mm. The species is named for G. E. Higgins in recognition of his contributions to the geology of Trinidad.



TEXTFIGURE 14

Holotype.—Recurvoides higginsi n. sp. Plate 15, Figure 5. 110×. Hg. 7318; T.L.L. Cat. No. 172604. Cruse formation, Miocene, South Trinidad. Maximum diameter 0.525 mm., thickness of walls 0.035 mm. to 0.050 mm. Deposited in Cushman Collection, U. S. National Museum, Washington, D. C., U. S. A.

Remarks.—R. higginsi is a small, subglobular species which can easily be separated from the large oblong and compressed *R. obsoletum* (Goës). In order to ascertain the taxonomic position, *R. higginsi* was compared with topotypes of *R. contortus* Earland 1934, the generotype of *Recurvoides* Earland, from Station D. 170, Discovery Expedition 1925, off Clarence Island, depth 342 m., kindly donated by C. D. Ovey, British Museum, London. *R. contortus* is typically streptospiral, the final volution however is close to *Haplophragmoides.* Ovey stated (letter 10th January, 1952) that he met with considerable difficulties when trying to segregate *R. contortus* from *Haplophragmoides scitulum* Brady. It is noteworthy that *H. scitulum* most probably belongs to *Labrospira* Höglund. Brady's equatorial section (pl. 34, fig. 13) demonstrates clearly that the apertures are almost basal but still interioareal like those of *Labrospira. R. contortus* is larger (diameter 0.75 mm. to 0.9 mm. and thickness 0.375 mm. to 0.425 mm.), typically biumbilically compressed like *Haplophragmoides* thus can easily be distinguished from the subglobular *R. higginsi. R. higginsi* also differs from *R. gillieparkeri* Smith 1948, described from the Miocene Harang fauna of Louisiana. Specimens of *R. gillieparkeri* originating from wells of the same locality as the holotype (Bully Camp, Lafourche Parish, Louisiana), kindly put at the writer's disposal by D. J. Smith, were compared with the Trinidad material. *R. gillieparkeri* with its umbilically compressed test of about 9 chambers in the final whorl is closer to *R. contortus* than to *R. higginsi.* The specimens of *R. gillieparkeri* show invariably a portion of the preced-



TEXTFIGURE 15

EXPLANATION OF TEXTFIGURES 14 & 15

Textfigure 14. *Recurvoides higginsi* Bronnimann, n. sp. Cruse formation, Miocene, South Trinidad. Hg. 7318; T.L.L. Cat. No. 172604. × 37.
a-i — Same specimen.

Textfigure 15.
a-g — *Eggerella forestensis* Bronnimann, n. sp. Cruse formation, Miocene, South Trinidad, B.W.I. S.L. 6637; T.L.L. Cat. No. 5220.
a-e — Various compressed specimens in side view. × 27.
f, g — Same compressed specimen. × 48.
h-o — *Valvulina flexilis* Cushman and Renz. Cruse formation, Miocene, South Trinidad. Hg. 230; T.L.L. Cat. No. 65478. All × 27.
h-k, o — 5 different specimens.
l-n — Same specimen.
p-w — (?) *Haplophragmoides,* sp. aff. *H. narivaensis* Bronnimann. Cruse formation, Miocene, South Trinidad. Apex well 193A; at 2372', T.L.L. Cat. No. 3371. All × 48.
4 compressed specimens in lateral and apertural view.

ing whorl. The last chambers are as a rule deformed and the apertures are not discernible. The maximum diameter of *R. gillieparkeri* ranges from 0.4 mm. to 0.525 mm., the thickness of the test from 0.25 mm. to 0.375 mm.

Recent specimens of *R. trochamminiforme* Höglund 1947 and of *R. laevigatum* Höglund 1947 both from the Koster Channel, Skagerak, collected 24-7-46, kindly donated by H. Höglund, Lysekil, Sweden, have also been compared with *R. higginsi* and found to be different from the Trinidad species. *R. trochamminiforme* has rather deeply incised sutures and *R. laevigatum* resembles somewhat *R. contortus* Earland, but is much smaller (0.16 mm. - 0.26 mm.) and in the adult retains the asymmetric form of the streptospiral test.

In broken up individuals of *R. higginsi* (textfigure 12, c, d, e), the streptospiral arrangement of the volutions is well recognizable by the changes in the position of the aperture during ontogeny. Textfigure 12c shows the equatorial section of the early volution with the initial chamber and the ?basal apertures. The slit like aperture of the penultimate chamber is distinctly interioareal.

Occurrence.—*R. higginsi* is associated with *R. obsoletum* (Goës). It is common in the clays of the Miocene Cruse formation and Lengua formation.

LITERATURE

Brady, H. B., 1884, Report Voyage Challenger: Zoology, Vol. 9.

Broeck, E. vanden, 1876, Etude sur les foraminifères de la Barbade (Antilles), recueillis par L. Agassiz, précédée de quelques considérations sur la classification et la nomenclature des foraminifères: Mém. Soc. Belge de Microscopie, Séance du 26 Fevrier, 1876, pp. 55-152.

Bronnimann, P., 1950, Occurrence and ontogeny of *Globigerinatella insueta* Cushman and Stainforth from the Oligocene of Trinidad, B.W.I.: Cushman Found. Foram. Research, Contr., Vol. I, Parts 3 and 4, pp. 80-82.

———, 1951, *Guppyella, Alveovalvulina,* and *Discamminoides,* new genera of arenaceous foraminifera from the Miocene of Trinidad, B.W.I.: Cushman Found. Foram. Research, Contr., Vol. II, Part 3, pp. 97-105.

Cushman, J. A., 1937, A monograph of the foraminiferal family Valvulinidae: Cushman Lab. Foram. Research, Special Pub. No. 8.

———, 1947, A supplement to the monograph of the foraminiferal family Valvulinidae: Cushman Lab. Foram. Research, Special Pub. No. 8A.

——— and Renz, H. H., 1941, New Oligocene-Miocene foraminifera from Venezuela: Cushman Lab. Foram. Research, Contr., Vol. 17, pp. 1-27.

——— and ———, 1947, The foraminiferal fauna of the Oligocene Ste. Croix formation of Trinidad, B.W.I.: Cushman Lab. Foram. Research, Special Pub. No. 22.

——— and Stainforth, R. M., 1945, The foraminifera of the Cipero Marl formation of Trinidad, B.W.I.: Cushman Lab. Foram. Research, Special Pub. No. 14.

Earland, A., 1934, Foraminifera, Part 2: The Falkland's Sector of the Antarctic (excluding Georgia): Zoology, Vol. 10.

Ellis, B. F. and Messina, A., 1940-1951, Catalogue of Foraminifera: American Mus. Nat. History, Special Publication.

Goës, A., 1896, Reports on the dredging operations off the West Coast of Central America to the Galapagos, to the West Coast of Mexico and in the Gulf of California: Part 20 — The Foraminifera: The Harvard College, Mus. Comp. Zoology, Bull., Vol. 29.

Höglund, H., 1947, Foraminifera in the Gullmar Fjord and the Skagerak: Zoologiska Bidrag fran Uppsala, Vol. 26.

Loeblich, Alfred R., and Tappan, Helen: 1953, Studies of Arctic Foraminifera: Smithson. Miscell. Coll. vol. 121, No. 7, Washington. 150 pp., 24 pls.

Palmer, D. K., 1938, Cuban foraminifera of the family Valvulinidae: Mem. Soc. Cubana Hist. Nat., Vol. 12, pp. 281-301.

Pope, D. E. and Smith, D. J., 1948, The Harang fauna of Louisiana: Dept. Cons., Louisiana Geol. Survey, Geol. Bull. No. 26.

Renz, H. H., 1942, Stratigraphy of Northern South America, Trinidad, and Barbados: Eighth Am. Sci. Congress, Proc. Geol. Sciences, Vol. 4, pp. 513-571.

———, 1948, Stratigraphy and Fauna of the Agua Salada Group, State of Falcon, Venezuela: Geol. Soc. America, Memoir 32.

Weynschenk, R., 1951, Two new foraminifera from the Dogger and Upper Triassic of the Sonnwend Mountains of Tyrol: Jour. Paleontology, Vol. 25, No. 6, pp. 793-795.

85. *PSEUDOCYCLAMMINA HEDBERGI* N. SP. FROM THE URGO-APTIAN AND ALBIAN OF VENEZUELA

WOLF MAYNC
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ABSTRACT—**Pseudocyclammina hedbergi** n. sp. from Urgonian to Middle Albian beds of Venezuela is described and figured. This species belongs to the coarsely labyrinthic **Lituus** type but with fewer and relatively large chambers in the last whorl. In this respect it shows morphological similarities with the small Upper Jurassic species **P. virguliana** Koechlin as well as with the large-sized Cenomanian form **P. rugosa** (Orb.).

Pseudocyclammina hedbergi n. sp. was also observed in Lower Cretaceous beds of Florida. An identical or at least closely related form occurs in Aptian limestones of southwestern France.

Another representative of **Pseudocyclammina** is listed as **Pseudocyclammina** sp. This small form is possibly a variety of **P. lituus** (Yokoyama); it occurs in Upper Aptian **Choffatella**-bearing limestones from Cuba and in Albian strata from East Venezuela and Florida.

The occurrence of **Pseudocyclammina lituus** (Yokoyama) and **Pseudocyclammina** n. sp. in the Lower Cretaceous of the Caribbean region was previously recorded by the writer (Maync, 1949, pp. 529 ff.). Studies of additional specimens appear to indicate that the above-mentioned forms belong to the same specific unit within its scope of variability for which the name **Pseudocyclammina hedbergi** n. sp. is proposed. This species is named in honor of Hollis D. Hedberg, in recognition of his outstanding contributions to the stratigraphy of Venezuela.

Unfortunately, no free specimens of this new species are available, hence the diagnosis is entirely based on thin-section studies.

DESCRIPTION OF SPECIES

Pseudocyclammina hedbergi, n. sp.

Plate 16, figures 1-8

Pseudocyclammina lituus (YOKOYAMA) MAYNC, 1949, Ecl. Geol. Helv., vol. 42, No. 2, p. 529.

Pseudocyclammina n. sp., MAYNC, 1949 (ibid.)

Pseudocyclammina lituus (YOKOYAMA) MAYNC, 1952, Contr. Cushman Found. For. Res., vol. III, pt. 2, June 1952, p. 50.

Pseudocyclammina n. sp. MAYNC, 1952 (ibid.).

Holotype: U. S. Nat. Mus. (Cushman Collection) 64541.

Paratypes: U. S. Nat. Mus. (Cushman Collection) 64542-64547.

Description.—Pseudocyclammina hedbergi, n. sp. shows a coarsely labyrinthic interior structure; its test sometimes contains incorporated small foraminifers (see Pl. 16, fig. 2). Structurally, it closely resembles *Pseudocyclammina lituus* (Yokoyama) Yabe and Hanzawa to which it had been referred by the writer (Maync, 1949, 1952). In *P. hedbergi,* however, the cancellous walls and septa are not as thick as those of the typical *lituus* (compare, Yabe and Hanzawa, 1926, Pl. II, figs. 3-6; Pfender, 1938, Pl. XIII, figs. 1-5; Henson, 1948, Pl. IX, figs. 2-3, Pl. XIII, fig. 7). Moreover, this Venezuelan species contains only 5 chambers in the last whorl whereas numerous narrow chambers make up the last whorl in *P. lituus.* The labyrinthic structural elements of the large *lituus* type usually are exuberantly developed at the expense of the chamber cavities. In *P. hedbergi,* on the other hand, the lumina are clearly outlined and relatively large and inflated. In this respect, *P. hedbergi* approaches *Pseudocyclammina virguliana* Koechlin (compare Koechlin, 1942, Pl. VI, figs. 1-2, 5-6; see Pl. 16, figs. 13-15 of the present paper) or *Pseudocyclammina rugosa* (Orb.) (compare Maync, 1952, Pl. 12, figs. 9-10). The new species differs from the Upper Jurassic *P. virguliana* in having a.) fewer chambers in the last whorl, b.) a coarser, *lituus*-like structure of walls and septa, and c.) a larger size (greatest diameter of 1.7-2.2 mm. in *P. hedbergi,* of 0.8-2 mm. in *P. virguliana* Koechlin).

Pseudocyclammina hedbergi differs from the Cenomanian form *P. rugosa* (Orb.) in its coarse labyrinthic interior structure (*lituus* type) and in showing a much less rounded, often even sub-acute periphery. The spiral portion of the test, furthermore, attains a diameter of more than 3 mm. in *P. rugosa* and is, therefore, more than twice as large as in the new Venezuelan species.

With respect to its morphology and internal structure, *P. hedbergi* occupies an intermediate position between the Jurassic species (*P. lituus, P. virguliana*) and the Cenomanian *P. rugosa.* This interrelation is also manifest in the intermediate stratigraphic occurrence of the new Venezuelan species (Lower Aptian to Middle Albian).

Type level.—Urgo-Aptian to Middle Albian of Venezuela, *P. hedbergi* occurs in limestone ledges interbedded in the Upper Barranquin formation and also in biohermal limestones of the Lower and Middle Chimana formation ("El Cantil limestone" auct., pars).

In the late Barranquin formation (?Barremian-Lower Aptian) it is associated with *Choffatella decipiens* Schlumberger, and in the higher formations of largely Middle Albian age with *Orbitolina concava-texana* (Roemer), *Dictyoconus walnutensis* (Carsey), *Textularia rioensis* Carsey, etc.

P. hedbergi is also found in the Aptian Lower Cogollo limestone ("Tomon" auct.) of West Venezuela (Maync, 1949, p. 530) and in the *Choffatella-* and *Orbitolina*-bearing subsurface strata (Trinity) of Florida[1]. [Compare *Pseudocyclammina lituus* (Yokoyama) and *P.* n. sp. in Maync, 1949, p. 529 ff.; *Pseudocyclammina lituus* (Yokoyama) in Jordan and Ap-

1 In a core sample from the Coastal Petroleum Company's deep-well No. 1, Pinellas County, Florida, kindly put at the writer's disposal by Mrs. E. R. Applin and Miss L. Jordan (see: Maync, 1949, p. 533).

plin, 1952, p. 31]. A subaxial section of a Floridan specimen is reproduced on Pl. 16, fig. 8.

Type locality.—El Cantil Cliff, Rio Punceres, State of Monagas, Venezuela, (Chimana formation).

COMMENTS—In their excellent manual "Corrélations stratigraphiques par Microfaciès en Aquitaine Occidentale," J. Cuvillier and V. Sacal (1951) have figured the spirocyclinine foraminifer **Choffatella decipiens** Schlumberger from Lower Aptian limestones (Pl. X, fig. 2; Pl. XI, figs. 1-2), and "large arenaceous lituolid foraminifers" which, undoubtedly (Pl. XIV, fig. 1; pl. XV, fig. 2; pl. XVI, fig. 1) are referable to the genus **Pseudocyclammina** Yabe and Hanzawa, 1926. Some specimens represented on Pl. XVI, fig. 1 in Cuvillier and Sacal evidently are closely allied to our new **P. hedbergi.**

These forms which occur in limestones of Middle and Upper Aptian age of southwestern France show a rather coarse labyrinthic wall and septal structure and large loculi with distinct contours. Four or five chambers make up the last-formed whorl. They are are so similar to **Pseudocyclammina hedbergi** that they are tentatively considered as being in affinity with **Pseudocyclammina hedbergi.**

Pseudocyclammina sp.
Plate 16, figures 9-12

Pseudocyclammina Maync, 1949, Eclogae Geol. Helv., Vol. 42, No. 2, pp. 532, 541.

A small species of *Pseudocyclammina* with the typical labyrinthic character of the inner structural elements was found in the fossiliferous Upper Aptian limestone from the Sierra de Jatibonico, Santa Clara Province, Cuba (see Maync, 1949, p. 541), where it is associated with *Choffatella decipiens* Schlumberger, *Textularia rioensis* Carsey, etc.

This form differs from all other described species in its small size (greatest diameter 0.6-1.3 mm.). Its broadly rounded periphery and thick labyrinthic walls and septa resemble the original *Lituus* type which, however, attains several times the dimensions of the Cuban form. There is, however, no other known species with which the present form, with is usually well developed uncoiled adult stage, could be compared. Since numerous specimens of *Choffatella decipiens* Schlumberger ("*Choffatelloid Pseudocyclammina,*" see: Maync, 1949, p. 541, footnote 24) in the same formation are dwarfed forms, not much emphasis should be laid upon the small size of this *Pseudocyclammina* species which might be a mere variety of *P. lituus* (Yokoyama). Owing to the fact that no conclusive median sections could hitherto be observed in the available material, a *nomenclatura aperta* seems to be advisable until more samples are at hand.

Specimens of *Pseudocyclammina* with a broadly rounded periphery (see Pl. 16, fig. 12) also occur in the Chimana formation of Venezuela, associated with *Pseudocyclammina hedbergi.* In all probability, they may be identical with *Pseudocyclammina* sp. from Cuba. (see Pl. 16, figs. 9-11).

The same form is present in the Trinity samples from Florida.

REFERENCES

Henson, F. R. S., 1948, Larger Imperforate Foraminifera of South-Western Asia. British Museum Nat. Hist., London, 1948, pp. 1-127, pls. I-XVI.

Jordan, L. and Applin, E. R., 1952, *Choffatella* in the Gulf Coastal Regions of the United States and description of *Anchispirocyclina* n. gen. Contributions Cushman Foundation Foram. Research, vol. III, pt. 1, March, 1952, pp. 1-5, pls. 1-3.

Koechlin, E., 1942, *Pseudocyclammina virguliana* n. sp. aus den *Virgula-Mergeln* des Berner Jura. Ecl. Geol. Helv., Vol. 35, No. 2, pp. 195-199, Pl. VI.

Maync, W., 1949, The foraminiferal genus *Choffatella* Schlumberger in the Lower Cretaceous of the Caribbean Region (Venezuela, Cuba, Mexico, and Florida). Ecl. Geol. Helv., Vol. 42, No. 2, pp. 529-547, pls. XI-XII.

———, 1952, Critical taxonomic study and nomenclatural revision of the Lituolidae based upon the prototype of the Family, *Lituola nautiloidea* Lamarck, 1804. Contributions Cushman Foundation Foram. Research, vol. III, pt. 2, June, 1952, pp. 35-56, pls. 9-12.

Pfender, J., 1938, Les Foraminifères du Valanginien Provençal. Soc. Géol. France, Bull., sér. 5, vol. VIII, pp. 231-242, Pls. XIII-XVI.

Yabe, H. and Hanzawa, Sh., 1926, *Choffatella* Schlum-

EXPLANATION OF PLATE 17

McLean: New Foraminifera from Lower Tertiary of New Jersey

Photo Nyholm

Nyholm: Recent Nemogullmia longevariabilis, n. gen., n. sp.

berger and *Pseudocyclammina*, a new genus of arenaceous foraminifera. Science Reports Tôhoku Imp. Univ., Sendai, Japan, 2nd ser. (Geol.), vol. IX, No. 1, pp. 9-11, Pl. II.

Yokoyama, M., 1890, Foraminiferen aus dem Kalksteine von Torinosu und Kompira. In: Naumann, E. and Neumayr, M., 1890, Geologie und Palaeontologie von Japan. Denkschr. kais. Akad. Wiss., Math.-Naturw. Cl., vol. LVII, Wien, pp. 26-27, Pl. V.

86. FOUR NEW SPECIES OF FORAMINIFERA FROM THE LOWER TERTIARY OF NEW JERSEY

James D. McLean, Jr.

INTRODUCTION

In material donated by Horace G. Richards of the Academy of Natural Sciences of Philadelphia, the author has found four species of Foraminifera which do not seem to belong to any known form. They are, therefore, here described as new.

The new species apparently have quite decided stratigraphic ranges and seem to serve well in separating two units in the New Jersey stratigraphic sequences: Two species are from the type locality of the Paleocene Vincentown Formation; the other two come from a bed of different lithologic characteristics than the type Vincentown. There is as yet no clear-cut evidence to indicate whether or not the Vincentown is contemporaneous with this bed; in the opinion of the author, the bed containing *Eponides beaberleae* n. sp. and *Marginulina conrathi* n. sp. is younger than the Vincentown formation, although other workers have classified it as Vincentown in age.

Holotypes are deposited with the Academy of Natural Sciences of Philadelphia (A.N.S.P.); figured paratypes (better designated as cotypes) are deposited in the U. S. National Museum (U.S.N.M.) and the American Museum of Natural History (A.M.N.H.). It is realized that there might be some objection to such a separation of type specimens. There are, however, two reasons for this separation: First, such a separation will better insure survival of specimens upon which an original species is based in the event of natural or other catastrophe, and Second, such a dispersal of specimens makes comparison material more readily available to a larger number of workers. The history of past losses of important types is a strong argument in favor of reviving the descriptive practice of designating cotypes instead of single holotypes. Another reason in favor of cotypic material (at least in the Foraminifera) is that adoption of this practice will allow the original description to cover some of the variations within the species.

ACKNOWLEDGMENTS

In addition to Horace G. Richards, who donated material upon which this paper is written, the author wishes to acknowledge the assistance of Mrs. Sally Lee, Scientific Illustrator, who kindly executed the drawings of type specimens.

DESCRIPTIONS OF THE NEW SPECIES

Family LAGENIDAE

Subfamily NODOSARIINAE

Genus **Marginulina** Orbigny, 1826

Marginulina conrathi McLean, n. sp.

Plate 17, figures 1-3

Test elongate, round in transverse section, slightly if at all compressed in early portion; early portion very slightly coiled, later portion linear or with a slight curve toward peripheral area: 11 chambers visible in holotype, fewer in most specimens, chambers very gradually increase in size as added; sutures show as rather broad bands of dark glassy material, flush in early part of test, depressed in later part; final chambers slightly inflated; wall smooth, glassy, ornamented with plate-like costae, some discontinuous, others traversing entire test, costae oblique to axis of test, definitely curved in direction of coiling in early portion, 6 to 8 costae visible to a side; aperture well developed, protruding, at the peripheral angle, radiate. Dimensions of holotype: length 1.66 mm.; breadth 0.37 mm.

Remarks.—This form resembles *Marginulina navarroana* Cushman, but is much less lobate, has a flatter apertural face and more regular plate-like costae. It is less compressed than *Marginulina cocoaensis* Cushman and the costae are inclined more to terminate without

EXPLANATION OF PLATE 18

traversing entire test. The coil is smaller than in *M. cocoaensis*, which is inclined to slanted sutures.

Named in honor of Theodore Barthel Conrath, Jr., of Alexandria, Virginia.

Types and Occurrences.—All types are from a well sample interval from 573 to 583 feet, well in Penn State Forest, one-half mile northwest of Bear Swamp Hill, Atlantic County, New Jersey. Samples collected by Horace G. Richards.

Holotype A.N.S.P. No. 19673; Paratype A.M.N.H. No. FT-1117; Paratype U.S.N.M. No. 548850.

Age and Ecology.—Wilcox Eocene (Vincentown? formation); ecology unknown, probably moderately deep waters.

Family ROTALIIDAE
Subfamily DISCORBISINAE
Genus **Discorbis** Lamarck, 1804

Discorbis toulmini McLean, n. sp.

Plate 17, figures 4-6

Discorbis sp. A. Toulmin, 1941, Jour. Pal. Vol. 15, p. 600, pl. 80, fig. 37, textfigure 4, H. I.

Test subcircular, convex on dorsal side, concave on ventral side, compressed; periphery rounded or slightly angulate, lobulate; 10 or more chambers to final whorl, chambers increase rather rapidly in size as added; sutures curved and somewhat limbate on both sides, flush or slightly raised in early portion, depressed in later portion of test; sutures merge into small umbilical cavity on ventral side; about 3 whorls visible on dorsal side in good specimens; wall perforate, glassy, ornamented with quantities of small spines whose amounts vary from specimen to specimen; aperture a thin slit under an overlapping flap between the periphery and umbilicus on ventral side. Dimensions of holotype; Diameter 0.44 mm.; thickness about 0.15 mm.

Remarks.—This form resembles *Discorbis newmanae* Plummer but is generally larger, has spines and the sutures of the dorsal side are more tangential to the whorl sutures. The umbilicus seems less well developed than in *D. newmanae*.

Named in honor of Lyman D. Toulmin of Florida State University, Tallahassee, Florida, who first encountered the form.

Types and Occurrences.—Holotypes and figured paratypes are all from a sample collected by Horace G. Richards at the type locality of the Vincentown formation, 0.3 to 0.5 miles northwest of the town of Vincentown, New Jersey, along the north bluff of Rancocas Creek in Burlington County.

Holotype A.N.S.P. No. 19672. Paratype A.M.N.H. No. FT-1115, U.S.N.M. No. 548849.

Age and Ecology.—Paleocene (Vincentown formation); ecology considered to be lagoonal or reefal by describer. The associated fauna indicated a deep to moderate depth series.

Subfamily ROTALIINAE
Genus **Eponides** Montfort, 1808

Eponides beaberleae McLean, n. sp.

Plate 17, figures 7-9

Dorsal side slightly convex, ventral side highly convex and becoming a flange toward the periphery; periphery a distinctive thick flange, lobulate and with a clear glassy border which is part of the glassy limbate sutures; 9 to 10 chambers in the final whorl of ventral side, chambers gradually increasing in size as added and bordered with limbate, slightly raised, glassy sutures; dorsal sutures straight to slightly curved and tangential to the periphery of the whorls; ventral sutures sinuous, merging into an indistinct glassy umbo; wall glassy and coarsely perforate; aperture a low opening at the base of the final chamber between the umbo and periphery on ventral side. Dimensions of holotype: diameter 0.76 mm.; thickness 0.37 mm.

Remarks.—This form greatly resembles *Eponides crebbsi* Hedberg but differs in being consistently larger, in having a more compressed dorsal side and a more distinctive flange. The umbo of *E. beaberleae* is more indistinct than that of *E. crebbsi* and the sutures are considerably thicker.

Named in honor of Mrs. Beatrice Conrath Berle, of Alexandria, Virginia.

Types and Occurrences.—All figured types are from a depth of 280 feet in a well at Point Pleasant, New Jersey; sample collected by Horace G. Richards.

Holotype A.N.S.P. No. 19674; Paratype U.S.N.M. No. 548851; Paratype A.M.N.H. No. FT-1118.

Age and Ecology.—Wilcox (?) Eocene (Vincentown ? formation) of New Jersey: ecology unknown; probably moderately deep waters.

Family ANOMALINIDAE
Subfamily ANOMALININAE
Genus **Anomalina** Orbigny, 1826

Anomalina pseudoammonoides McLean, n. sp.

Plate 17, figures 10-13

Test about normal size for the genus, slightly trochoid, periphery lobulate, rounded, with a thick but not highly-raised peripheral keel; 9 to 12 chambers in final whorl. chambers distinct and inflated, sutures deeply incised in final whorl; final chamber usually large, others increasing gradually in size as added; a large open umbilicus on ventral side; dorsal side shows two whorls; wall uniformly and coarsely perforate; apertural face variable but generally triangulate and inflated; aperture a well-defined arch extending over the periphery and towards the umbilicus, aperture lipped. Dimension of holotype; diameter 0.58 mm.; thickness 0.35 mm. at thickest portion.

Remarks.—This interesting form has apparently been confused with *Anomalina ammonoides* (Reuss). It differs from it in having an excavated umbilicus, a keel or rim, and non-limbate, unraised sutures.

Types and Occurrences.—Holotype and paratypes are all from a sample collected by Horace G. Richards at the type locality of the Vincentown formation, 0.3 to 0.5 miles northwest of the town of Vincentown, New Jersey, along the north bluff of Rancocas Creek in Burlington County.

Holotype A.N.S.P. No. 19671; Paratype A.M.N.H. No. FT-1116; U.S.N.M. No. 548848

Age and Ecology Paleocene (Vincentown formation); ecology considered to be lagoonal or reefal by describer. The associated fauna indicates moderate or deep waters.

87. STUDIES ON RECENT ALLOGROMIIDAE (2): *NEMOGULLMIA LONGEVARIABILIS* N. G., N. SP. FROM THE GULLMAR FJORD

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Studies of the microfaunal content of soft sediments in the Gullmar Fjord (Sweden) have brought to light the presence of a new genus of Foraminifera, which is herewith described.

Nemogullmia longevariabilis Nyholm, n. gen., n. sp.
Plate 18, figures 1-5. Textfigures 1-5

Description.—Single straight, bent or twisted threads with form-constant, transparent, non-striated, chitinoid test; plasma opaque with or without wrinkles; temporary narrow apertures at both ends of test; pseudopodia when first extruded cordiform, finally filireticulous. Agglutination of detritus on test can occur, depending on interapertural extrusion of plasma. One or more nuclei present.

Size.—1.6 to 19.0 mm. in length (not extended specimens).

Habitat.—Marine.

Occurrence.—Detritus-layer on top of soft bottoms at depth of 100 to 118 meters in Gullmar Fjord, Sweden.

Depositary of Types.—Department of Zoology, University of Uppsala.

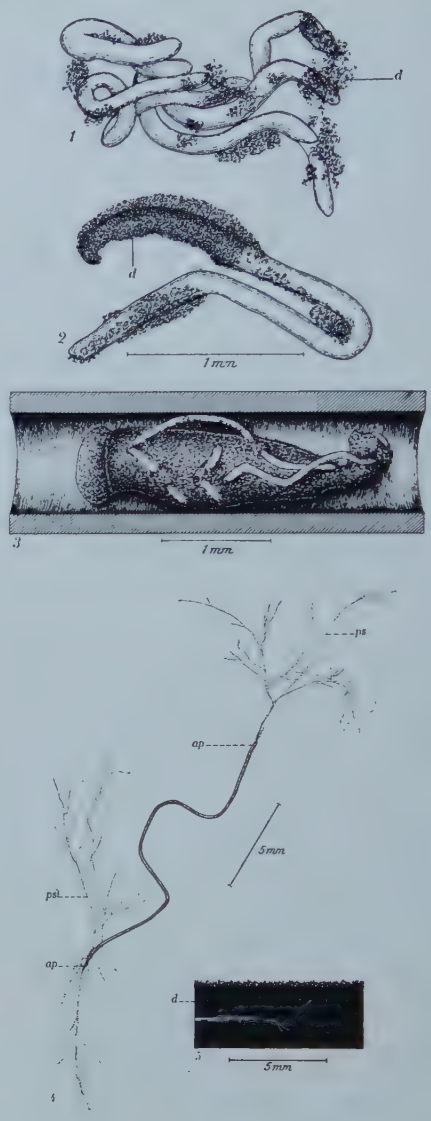
Remarks.—When studying the recent microfauna of soft sediments in the Gullmar Fjord short usually white threads were found, the nature of which was difficult to make out at first. The threads consists of living plasma. Since all early cultures were unsuccessful, attempts to interpret these organisms failed until it became possible to keep the threads alive for months during autumn and winter time when the changes in temperature at different layers were less pronounced. It was observed in cultures that these filamentous organisms were indeed monothalamous Foraminifera feeding on detritus and increasing considerably in growth.

Remarks.—It has not been possible to obtain specimens of *Nemogullmia* with core samplers; they are obtainable primarily with a sledgenet. The species seems to be about equally common in summer and in winter. During the summer they are easily damaged owing to the high temperature in the upper water layers. If suitable cooling arrangements cannot be used directly after dredging, it is preferable to study this material in the winter. Culture is necessary to obtain an idea of the changing form, the type of pseudopodia and the ingestion of food. Cultures can now be made repeatedly at temperatures of 6-9° C. in detritus taken at a depth of about 100 m., from the locality where the species is found, and it has been possible to observe amongst other things the type of pseudopodia in detail (Text Fig. 4). When the pseudopodial plasma appeared in the form of a long single string, which did not develop any further, the specimens proved to have been damaged by the action of light. The pseudopodia finally formed are filireticulous (Text Figs. 4, 5). The extent of the whole pseudopodial net in the cultures depends largely on the supply of detritus. When culturing on a glass slide with a thin layer of detritus a specimen with a maximum length of 2.5 cm. between the distal apertures was observed to have a maximum plasma net outside the apertures of about 2 cm^2. Detritus accumulation on the chitinoid test appear in a number of specimens in the preserved material (Pl. 18, Fig. 2, Text Figs. 1-3). Such an accumulation of detritus on cultured material is apparently caused by contraction of the more or less well-developed plasma net. This can occur also between the apertures of the thread when the thread is bent and the interapertural plasma net appears more frequent, resulting in a rich agglutination of detritus especially on the points of the thread. The colour of the test is usually white. In some cases pale red specimens were observed. According to our observations the tests are found free in the detritus. On two occasions a specimen of *Nemogullmia* was found in empty worm-tubes (Text Fig. 3), and several times twisted forms were observed (Text Fig. 1).

Discussion.—It is difficult to determine the exact taxonomic position of *Nemogullmia*. This is not surprising as the position of many monothalamous forms, which have been known for a long time, is still uncertain.

Shepheardella taeniformis described by Siddall (1880) is placed by Rhumbler among the *Allogromiidae*. This

allocation shows that Rhumbler (1904) does not assign a decisive role to one of the characteristics he himself gave for *Allogromiidae,* namely that the pseudopodial plasma does not emerge from any other place than the apertures. In *Shepheardella,* which has been studied alive, the pseudopodial plasma also emerges from the chitinoid test between the apertures. As several of the *Allogromiidae* have not been investigated alive it is impossible to state definitely that interapertural pseudopodia are always lacking. Until the information needed for a taxonomic revision of the Monothalamia has been obtained it is, therefore, not unreasonable to include *Nemogullmia* in the *Allogromiidae* for the time being. There are, however, certain resemblances in morphology between part of the preserved material of *Nemogullmia* and the genera *Dendrotuba* and *Ophiotuba* described by Rhumbler from preserved material only. Both these genera have been classed as *Rhizamminae* types (Rhumbler 1904, p. 251). Although these forms are relatively small (0.7-5 mm.) and known only from the empty shells of larger foraminifers, much new information would probably be obtained from a culture of these forms, f.i. facts explaining the relations to *Allogromiidae* in general and also certain phases of the life-cycle of *Nemogullmia* where many small nuclei may appear as is the case in *Ophiotuba* (Pl. 18, Figs. 3-5).



REFERENCES

RHUMBLER, L., 1904, Systematische Zusammenstellung der rezenten Reticulosa (Nuda Foraminifera): Arch. f. Protistenkunde, vol. 3, Jena.

SIDDALL, J. D., 1880, On *Shepheardella,* an undescribed type of marine Rhizopoda, etc. Quart. Jour. Micr. Sc., n. s., vol. 20. London.

Text Fig. 1: Twisted specimen of *Nemogullmia.* d: detritus
Text Fig. 2: Bent specimen of *Nemogullmia.* (preserved material) d: detritus
Text Fig. 3: *Nemogullmia* in an empty worm-tube.
Text Fig. 4: Extended specimen of *Nemogullmia* with pseudopodia (ps); ap: aperture
Text Fig. 5: A part of a specimen of *Nemogullmia* in the detritus-layer

RECENT LITERATURE ON THE FORAMINIFERA

Below are given some of the more recent works on the Foraminifera that have come to hand.

ALLIATA, ENRICO di NAPOLI. **Cibicides italicus** nuova specie di foraminifero del Neogene italiano.—Riv. Ital. Pal. Stratig., vol. 58, No. 1, 1952, pp. 1-15, pl. 1.—Description of the species and lists of smaller Foraminifera.

Foraminiferi pelagici e facies in Italia.—Atti VII Conv. Naz. Met. e Petr., April 1952, pp. 1-34, pls. 1-5.—Geographic and quantitative distribution in Recent Mediterranean sediments are recorded and stratigraphic ranges of 77 planktonic species and varieties in the Cretaceous and Tertiary of Italy are plotted.

ARANA, TRINIDAD del PAN. Contribution al estudio de los Microforaminiferos del Mióceno de Sevilla.—Bol. Real Soc. Española Hist. Nat., sec. Geol., vol. 50, No. 1, 1952, pp. 121-130, text figs. 1-5.

ASANO, KIYOSHI. Paleogene Foraminifera from the Ishikari and Kushiro Coal-Fields, Hokkaido.—Short Papers from the Institute of Geology and Paleontology, Tohoku Univ., Sendai, No. 4, June 17, 1952, pp. 23-46, pls. 3-5, text fig. 1 (map), tables 1, 2.—Twenty-seven species 3 new, are recorded and illustrated from the Poronai shale.

Foraminifera from the Miocene Takinoue formation near Momijiyama, Hokkaido.—Short Papers from the Institute of Geology and Paleontology, Tohoku Univ.,

Sendai, No. 4, June 17, 1952, pp. 47-51, pl. 6.—Seven species, 2 new and 3 undetermined, are recorded and figured.

BANDY, ORVILLE L. Ecology and paleoecology of some California Foraminifera. Part I. The frequency distribution of Recent Foraminifera off California.—Journ. Pal., vol. 27, No. 2, March 1953, pp. 161-182, pls. 21-25, text figs. 1-4, table 1.—Five zones are recognized in 3 profiles. The dominant benthonic species are recorded and illustrated, and their occurrence represented graphically. Four new species and 3 new varieties are described.

Part II. Foraminiferal evidence of subsidence rates in the Ventura Basin.—L. c., pp. 200-203, text figs. 1-3. —Dominance of Foraminifera species gives evidence for water depths during deposition.

BARTENSTEIN, HELMUT. Systematisch-taxonomische Bemerkungen zu den Foraminiferen-Gattungen **Tribrachia** Loeblich & Tappan, **Tetraplasia** Bartenstein & Brand und **Centenarina** Majzon.—Pal. Zeitschrift, vol. 26, Nr. 3/4, Dec. 1952, pp. 248-254, text figs. 1-3.

Taxonomische Revision und Nomenklator zu Franz E. Hecht "Standard-Gliederung der Nordwest-deutschen Unterkreide nach Foraminiferen" (1938). Teil 2: Barrême.—Senckenbergiana, vol. 33, No. 4/6, Nov. 15, 1952, pp. 297-312, text figs. 1-6.—Five new species and one unnamed one are described and illustrated.

Taxonomische Bemerkungen zu den **Ammobaculites, Haplophragmium, Lituola** und verwandten Gattungen (For.).—Senckenbergiana, vol. 33, No. 4/6, Nov. 15, 1952, pp. 313-342, pls. 1-7, text figs. 1, 2, table 1.—Ten species and subspecies of the three genera are discussed and illustrated. A new name is proposed and 2 new subspecies are described. A chart shows ranges and evolutionary relationships of the various species in the Dogger, Malm, and Lower Cretaceous.

BARTENSTEIN, HELMUT, and BRAND, ERICH. Nomina nova für Foraminiferen-Homonyme zu Bartenstein & Brand 1951, Valendis.—Senckenbergiana, vol. 33, No. 4/6, Nov. 15, 1952, pp. 342, 343.

BERMUDEZ, PEDRO J. Estudio sistematico de los Foraminiferos rotaliformes.—Ministerio de Minas e Hidrocarburos Boletin de Geologia, vol. 2, No. 4, 1952, pp. 1-230, pls. 1-35.—Following Glaessner's classification of the superfamily Rotaliidea, 289 genera are included, most of them illustrated by one or more species. Fifteen new genera are erected: **Planispirillina** (genotype **Spirillina limbata** Brady var. **papillosa** Cushman 1915), **Pileolina** (genotype **Valvulina pileolus** d'Orbigny 1839), **Bronnimannia** (genotype **Discorbis palmerae** Bermudez 1935), **Lamellodiscorbis** (genotype **Discorbina dimidiata** Parker and Jones 1862), **Planodiscorbis** (genotype **Discorbina rarescens** Brady 1884), **Praeglobotruncana** (genotype **Globorotalia delrioensis** Plummer 1931), **Asterigerinoides** (genotype **Discorbina gürichi** Franke 1912), **Rolshausenia** (genotype **Rotalia rolshauseni** Cushman and Bermudez 1946), **Charltonina** (genotype **Pseudoparrella madrugaensis** Cushman and Bermudez 1948), **Hofkerinella** (genotype **Nautilus balthicus** Schroeter 1783), **Neorotalia** (genotype **Rotalia mexicana** Nuttall 1928), **Thalmannita** (genotype **Rotalia madrugaensis** Cushman and Bermudez 1947), **Caribeanella** (genotype **C. polystoma** n. sp.), **Planogypsina** (genotype **Gypsina vesicularis** var. **squamiformis** Chapman 1901), **Hemigypsina** (genotype **Gypsina mastelensis** Bursch 1947).

El genero **Asterigerinata** (Foraminiferos) y sus especies. —Mem. Soc. Ciencias Nat. La Salle, vol. 12, No. 32, May-August 1952, pp. 201-210, pls. 1-3.—Nine species, 2 new, and one new variety, are illustrated and included in the genus.

BETTENSTAEDT, FRANZ. Stratigraphisch wichtige Foraminiferen-Arten aus dem Barrême vorwiegend Nordwest-Deutschlands.—Senckenbergiana, vol. 33, No. 4/6, Nov. 15, 1952, pp. 263-295, pls. 1-4, distribution and abundance chart.—Seven new species and three new subspecies are described. The variation and evolutionary development of one species and its subspecies are illustrated.

BULLARD, FREDDA JEAN. Polymorphinidae of the Cretaceous (Cenomanian) Del Rio shale.—Journ. Pal., vol. 27, No. 3, May 1953, pp. 338-346, pls. 45, 46, text fig. 1.—Nineteen species, 6 new, are described and their occurrence and abundance plotted.

CARBONNIER, ANDRÉ. A propos de ma note: "Sur un gisement de Foraminifères d'âge cénomanien supérieur, provement de la région de Taza (Maroc)."—C.R.S. Soc. Géol. France, No. 2, Jan. 19, 1953, p. 20.—**Gaudryina tazaensis** new name for **G. inflata** Carbonnier (not Israelsky).

CARTER, D. J. Statistical study of **Operculina**.—Journ. Pal., vol. 27, No. 2, March 1953, pp. 238-250, pls. 33, 34, text figs. 1-9.

CLOUD, PRESTON E. JR., and COLE, W. STORRS. Eocene Foraminifera from Guam, and their implications. —Science, vol. 117, No. 3039, March 27, 1953, pp. 323, 324.—Larger Foraminifera are listed and indicate correlation with Tertiary **b**.

COLE, W. STORRS. Eocene and Oligocene Larger Foraminifera from the Panama Canal Zone and vicinity. —U. S. Geol. Survey Prof. Paper 244, 1952 (March 11, 1953), pp. 1-41, pls. 1-28, text figs. 1, 2.—Descriptions and illustrations of 40 species, 1 new, and 2 varieties are included. Correlations of formations are made.

Some Late Oligocene larger Foraminifera from Panama. —Journ. Pal., vol. 27, No. 3, May 1953, pp. 332-337, pls. 43, 44.—Four species, none new.

COLOM, G. Foraminíferos de las costas de Galicia (Campañas del "Xauen" en 1949 y 1950).—Bol. Instit. Español Oceanografía, No. 51, June 7, 1952, pp. 1-59, pls. 1-8, text figs. 1-5, map, distribution chart.—A fauna of about 125 species and varieties, 2 new, is recorded and illustrated, and distribution and abundance plotted against depth. The fauna falls into four associations.

Los caracteres micropaleontológicos de algunas formaciones del Secundario de España.—Bol. Instit. Geol. Min. España, vol. 64, 1952, pp. 1-88, pls. 1-14, text figs. 1-3 (stratigraphic section and distribution tables). —Smaller Foraminifera from several sections and one well in Spain, mostly Cretaceous but including some Lias, are recorded and illustrated. One species is new.

CUVILLIER, JEAN. Etude stratigraphie du grand forage de Bastennes-Gaujacq (Landes).—Geol. Appliquée et Prospection Minière, vol. 3, No. 4, 1950, pp. 5-14, pls. 1-4.—The well cuts lower Lutetian to Aptian strata. Foraminifera are listed and a few illustrated in thin sections.

La notion de "microfacies" et ses applications.—Atti VII Conv. Naz. Met. e Petr., April 1952, pp. 1-5, pls. 1-6 (text figs.).

Paleogeographie de l'Égypte au début des temps Tertiaires.—Bull. Soc. Roy. Géogr. Égypte, vol. 25, March 1953, pp. 5-7.

DROOGER, C. W. Late Eocene smaller Foraminifera

from Curaçao and Bonaire (N. W. I.).—Proc. Kon. Nederl. Akad. Wetenschappen, ser. B, vol. 56, No. 1, 1953, pp. 93-103, pl. 1, text figs. 1-5.—Fifty-nine species, none new, are recorded in a check list. A few of these are illustrated.

Some Indonesian Miogypsinae: I, Introduction and descriptions, II, Classification and phylogeny.—Proc. Kon. Nederl. Akad. Wetenschappen, ser. B, vol. 56, No. 1, 1953, pp. 104-123, pls. 1, 2.—Eight species and one variety of **Miogypsina,** none new, are discussed.

EMILIANI, C., and EPSTEIN, S. Temperature variations in the lower Pleistocene of southern California.—Journ. Geol., vol. 61, No. 2, March 1953, pp. 171-181, text figs. 1-6.—Three genera of Foraminifera used in isotope analysis give similar but not identical indications of paleotemperatures and thermic variations. Possible causes of differences and variations are discussed.

GLAESSNER, MARTIN F. Time-stratigraphy and the Miocene epoch.—Bull. Geol. Soc. Amer., vol. 64, No. 6, June 1953, pp. 647-658.

HAGN, HERBERT. Zur Kenntnis von Helvetikum und Flysch im Raum von Neubeuern am Inn.—Geologica Bavarica, No. 14, 1952, pp. 69-75.—Includes correlation chart.

Zur Kenntnis der obersten Kreide am Nordfuss des Untersberges (Salzburger Alpen).—Neues Jahrb. fur Geol. Päl., Mh. 5, May 1952, pp. 203-223.

Zur Kenntnis des Unteren Obercampans (Zone der **Belemnitella mucronata** [Schloth.] mut **senior** Nowak) in Südbayern.—Neues Jahrb. fur Geol. Päl., Abhandl., vol. 96, February 1953, pp. 304-338, pl. 8.—Includes distribution table.

HAMILTON, EDWIN L. Upper Cretaceous, Tertiary, and Recent planktonic Foraminifera from mid-Pacific flat-topped seamounts.—Journ. Pal., vol. 27, No. 2, March 1953, pp. 204-237, pls. 29-32, text figs. 1-4b.—Dredgings and cores from 5 guyots yielded fossil planktonic faunas that permit dating of events in geologic history and interpretation of sedimentation in the mid-Pacific region. Eighty-seven species and varieties, one species new, are recorded and most of them illustrated.

HARRIS, R. W., and JOBE, BILLYE IRENE. Microfauna of basal Midway outcrops near Hope, Arkansas.—The Transcript Press, Norman, Oklahoma, October 1951, pp. 1-113, pls. 1-14, tables 1-5.—One hundred fifty species and varieties of Foraminifera, 31 new, are recorded and illustrated from 58 samples from 5 localities.

ISHIZAKI, KAZUHIKO. Six new fossil species of **Streblus** from eastern Asia.—Acta Geol. Taiwanica, vol. 2, No. 1, July 1948, pp. 55-66, pl. 1.—All from the Pliocene of Taiwan and Japan.

LOEBLICH, ALFRED R. JR., and TAPPAN, HELEN. Studies of Arctic Foraminifera.—Smithsonian Misc. Coll., vol. 121, No. 7, April 2, 1953, pp. 1-150, pls. 1-24, text fig. 1.—A taxonomic study, including 110 species, of which 21 are new, and one new name proposed. Six new genera are erected: **Ammotium** (genotype **Lituola cassis** Parker), **Scutuloris** (genotype **S. tegminis** n. sp.), **Pateoris** (genotype **Quinqueloculina subrotunda** (Montagu) forma **hauerinoides** Rhumbler), **Laryngosigma** (genotype **L. hyalascidia** n. sp.), **Esosyrinx** (genotype **Pseudopolymorphina curta** Cushman and Ozawa 1930), **Trichohyalus** (genotype **Discorbis bartletti** Cushman 1933).

LOVE, J. D., HENBEST, L. G., and DENSON, N. M. Stratigraphy and Paleontology of Paleozoic Rocks, Hartville area, eastern Wyoming.—U. S. Geol. Survey Oil and Gas Investigations Chart OC 44 (in 2 sheets), 1953.—Numerous fusulinids are listed, some are illustrated, and their occurrence indicated on stratigraphic sections, and in a check list.

MURATA, SHIGEO. On the paleo-ecological investigation of the fossil foraminiferal fauna in the Miyazaki group with description of new species.—Bull. Fukuoka Kyushu Instit. Tech., No. 1, March 1951, pp. 91-104, pl. 1, text fig. 1 (map), tables 1-6 (range charts).—A quantitative study of five sections across an area including four Miocene formations indicates ecologic change from north to south of inland sea to open sea conditions. Three new species are described.

THOMPSON, M. L. Primitive **Fusulinella** from southern Missouri.—Journ. Pal., vol. 27, No. 3, May 1953, pp. 321-327, pls. 41, 42.—Two new species.

TOMIC-DZODZO, RADOJKA. A paleontological treatise of microfauna from the well drilling Tusanj III—Donja Tuzla (Bosnia).—Zbornik Radova, vol. 23, No. 4, 1952, pp. 243-267, pls. 1-9, text fig. 1 (map). (English summary pp. 263-266).—Smaller Foraminifera are recorded and illustrated from Eocene and Miocene strata.

TORIYAMA, RYUZO. New peculiar fusulinid genus from the Akiyoshi limestone of southwestern Japan.—Journ. Pal., vol. 27, No. 2, March 1953, pp. 251-256, pls. 35, 36.—**Akiyoshiella** n. gen. (genotype **A. ozawai** n. sp.).

VELJKOVIC-ZAJEC, KATARINA. Paleontological description of microfauna from a deep bore-hole Bechej I.—Zbornik Radova, vol. 22, No. 3, 1952, pp. 149-167, pls. 1-5 (English summary, pp. 155, 156).—A few species from the Miocene and Upper Cretaceous are described.

ZELLER, DORIS E. NODINE. Endothyroid Foraminifera and ancestral fusulinids from the type Chesteran (Upper Mississippian).—Journ. Pal., vol. 27, No. 2, March 1953, pp. 183-199, pls. 26-28, text figs. 1-9, chart 1, tables 1-3.—Three species of **Millerella** and 7 of **Plectogyra**, all new, are described.

RUTH TODD

SPECIAL PUBLICATIONS

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No. 1. An Eocene foraminiferal fauna from the Agua Fresca shale of Magallanes Province, southernmost Chile. 28 pages, 4 plates and one map. September 2, 1952. Ruth Todd and Hedwig T. Kniker $1.50

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